MOISTURE STORAGE *and* CROP YIELDS *in the* DRYFARMING AREAS *of the* GREAT PLAINS

as affected by natural and farm operational factors

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Contents

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Moisture Storage and Crop Yields in the Dryfarming Areas of the Great Plains, as Affected by Natural and Farm Operational Factors

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This study traces the effects of farm operational and naturally occurring factors on the accumulation of soil moisture during the idle period between crops and on crop yields in the dryland areas of the Great Plains, 1947–51. Temperature and rainfall during the growing season of the crop and the farming practices carried out while the crop was growing were not included.

An earlier report [3] dealt with the efficiency of intake and retention of moisture during the idle period between crops. The 17,680 records available for that study were analyzed on the basis of specific locations.

The data for the present study were regrouped on the basis of three general farming areas of the Great Plains and for specific crops. Minor crop records too few or too scattered to make up a category for separate study were eliminated, and thus the total volume of available records was reduced to 15,077.

Sampling procedure was at random within districts, so as to provide an accurate picture of average agricultural conditions of representative districts. However, certain farms that lacked detailed soil surveys or the operators of which were unwilling to cooperate in supplying desired information were excluded from the study. A farmer did not modify his practices for purposes of comparison.

Within the limitations and designations of selected districts agreed upon by State agricultural experiment stations and the research committee of the Soil Conservation Service, a very good cross section of semiarid agriculture of the Great Plains has been obtained. The outline map (fig. 1) shows the location of sample districts and the regional subdivisions used in this study.

The data covered by the time interval in this study are sufficiently representative of climatic conditions in the Great Plains and of the average crop yields obtained that they could be used for other years in this region in interpreting similar problems.

Presentation of Data

The crops represented and their distribution were such as to afford 13 groups or crop areas suitable for statistical analysis (table 1). All variables, units of expression, and factor symbols are listed in table 2, Appendix.

Means and coefficients of variation of the operational and natural variables for different crop groups in different areas of the Great Plains were determined. (Tables 3 through 9, Appendix.)

Tables 10 through 14 (Appendix) bring together for each crop group the simple correlation coefficients (r) and the corresponding standard partial regression coefficients (b) for all factors tested relative to soil moisture accumulation during the period between crops in the different areas of the Great Plains. Similar relationships for all factors and crop yields are shown in tables 15 through 19, Appendix.

TABLE 1.—*Number of records by crops and areas, Great Plains, 1947–51*

Crop	Area: Northern	Central	Southern
	Number	*Number*	*Number*
Wheat	2,652	2,079	3,567
Oats	670	521	295
Barley	483	621	498
Corn	1,059	623	----------
Grain sorghum	----------	431	1,578

[1] Retired June 30, 1959.

[2] The Oklahoma Agricultural Experiment Station analyzed the statistical data for the report; the State Agricultural experiment stations of Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Texas cooperated in the planning of the field work of this study. The Soil Conservation Service technicians personally responsible for the collection of field data at different stages of the project were Merritt E. Anderson, Chamberlain, S. Dak.; Roy V. Bailey, Perryton, Tex.; Ellis M. Baker, Oberlin, Kans.; J. D. Chapman, Las Cruces, N. Mex.; David K. Daubert, Littleton, Colo.; Alvin H. Jackson, Silverton, Tex.; Rannell R. Jones, Clovis, N. Mex.; Vincent R. Killerlain, Burlington, Colo.; Bruno Klinger, Fort Collins, Colo.; Oliver R. Nuzum, Osborne, Kans.; Olmon W. Sweat, Plainview, Tex.; William R. White, Clovis, N. Mex.; and George Truman Williams, Stanley, N. Dak.

[3] FINNELL, H. H. FACTORS AFFECTING MOISTURE STORAGE EFFICIENCY OF DRYFARMING AREAS IN THE GREAT PLAINS. U.S. Dept. Agr. Prod. Res. Rpt. 37, 7 pp., illus. 1960.

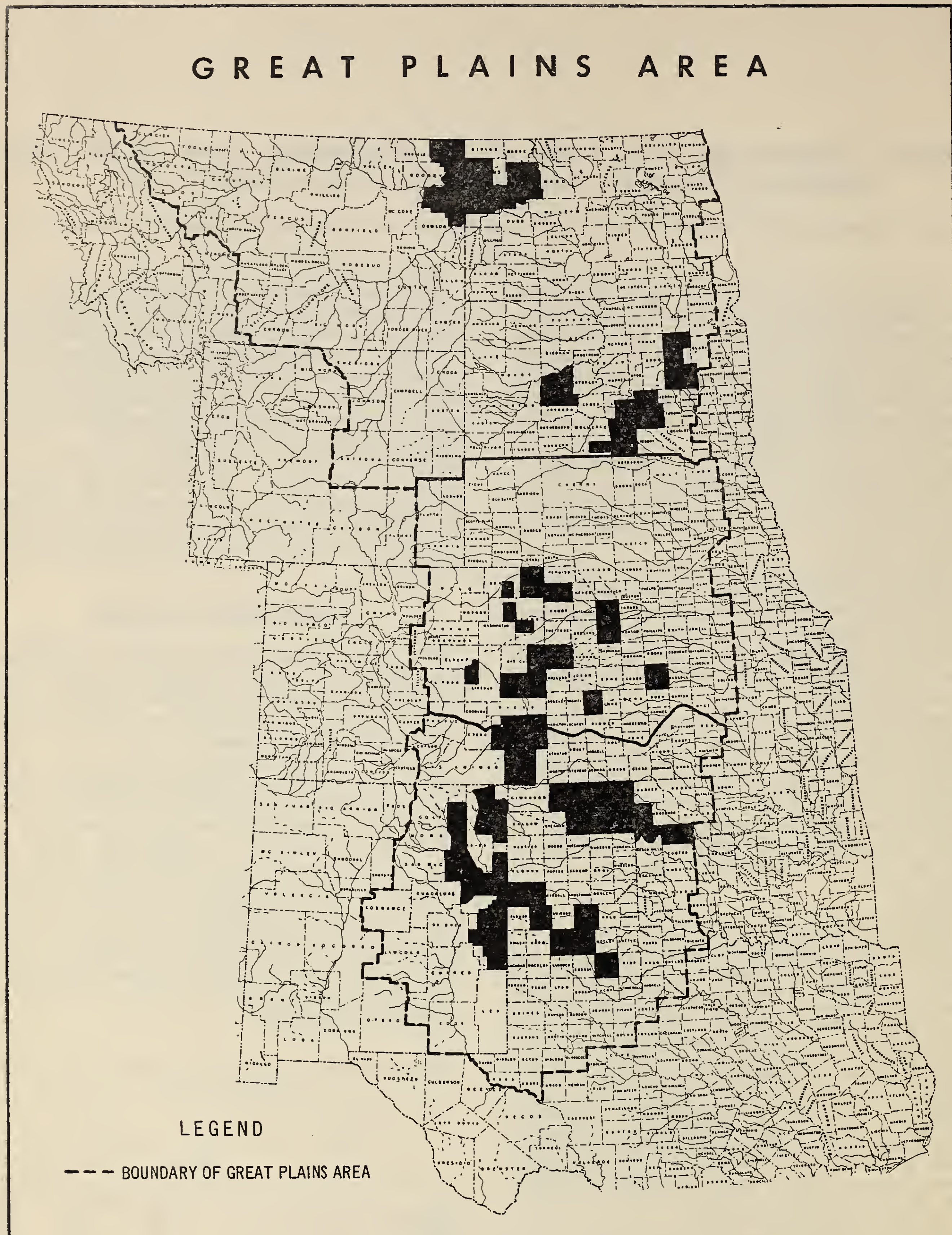

FIGURE 1.—Location of sample areas.

Complete simple correlation coefficients (r) for each of the 13 crop areas are presented in tables 20 through 32, Appendix.

Discussion

Simple Correlations Between Factors

In tables 10 through 19, significant simple correlations between variables were obtained in numerous instances in the absence of significant standard partial regression coefficients. The reverse can also be seen, as well as reversals in sign in some cases. These apparent inconsistencies probably are due in most instances to associations between independent variables that result in marked interaction in the multiple regression analyses. This causes changes in the apparent reaction of yield or moisture accumulation to the individual factors.

For example, moisture accumulation (IM) was strongly correlated in all instances with total rainfall during preparation (TR). However, in tables 20 through 32, the total rainfall (TR) is generally well correlated with a number of other factors—length of preparatory period (L), tillage intensity (D), rainfall per week (WR), and total precipitation (P). When the effects of these associated variables were removed through multiple regression in an attempt to assess the independent effect of total rainfall (TR), the significance of this variable in many cases disappeared.

Such associations occurred for most variables as would be expected where so many were considered. In no case would this behavior be considered negligible.

Standard partial regression coefficients have been relied upon to give the best available separate evaluation of each factor. Most significant was finding factors that reacted consistently with all crops in all parts of the Great Plains. Highly important, as well, were the instances of consistent behavior with respect to any readily defined physical environment. Nevertheless, special or exceptional cases should not be neglected, for they often lead to a useful, though singular, behavior.

Observation of significance for a simple correlation did not necessarily result in significance for the corresponding standard partial regression coefficients. This reflects marked interaction or association between variables as would be anticipated.

In interpreting the standard partial regression coefficients several considerations must be kept in mind:

(1) Occasional observance or failure to observe significance may be due either to chance with the large number of variables under study or to the nature of the data.

(2) In the case of certain variables, the variation encountered may be inadequate to yield significance.

(3) In the case of certain variables, significance may be observed in all cases due to the mechanics of analysis. For example, the effect of increased moisture storage efficiency would be to increase moisture accumulation if effects of all other variables are eliminated.

(4) In the case of certain variables, inherent associations between variables makes interpretation difficult as previously expressed.

(5) Interpretation of certain variables, notably water conservation practices and perhaps others, may be difficult due to inherent limitations in the original basis for indexing.

(6) The multiple regression analysis assumes linear relationships, whereas true relationships are probably curvilinear in many cases. This generally tends to reduce the level of significance observed.

These factors, although largely unavoidable, place some limitation on the interpretability of the data and must be recognized in use of them.

Effects of Individual Factors on Moisture Accumulation and Yield

Land capability (LC) is a system of grouping soils, established by the Soil Conservation Service, to indicate the potentiality and limitations of land for sustained production.

Physical characteristics of the land and climatic environment determine the capability rating. Rating numbers were used in this study as a code to land capability. Since the numbers are inverse numerically to the desirability of the land for agricultural purposes, a negative r or standard partial regression coefficient would be the expected behavior.

Lands found in cultivation generally averaged a better capability rating in northern and southern areas than in the central area.

Negative standard partial regressions were consistently obtained for moisture accumulation for small grains in the central Great Plains, whereas a positive relationship occurred for sorghum in the southern Plains. For yield, all significant regressions were negative for land capability, which indicates general validity of the rating system if current trends are indicative of long-term behavior.

Latitudes (La) were recorded to the nearest whole degree. Means shown in table 3 locate roughly the centers of distribution relative to other crops. Together with the altitude, the latitudes indicate the evenness of distribution within the regional areas.

Moisture storage appeared to be favored as latitude degrees moved northward. Yields did not follow any consistent pattern, and most regressions were indicated as nonsignificant.

Altitude (*Al*) was recorded to the nearest 100-foot level for each field. Variability in elevation was greatest in the central area, where the westernmost districts lay just off the foothills of the Colorado Rockies. However, wheat and sorghum lands of the southern Plains averaged practically as high in elevation as the central area. Generally, centers of distribution indicated by latitude and altitude showed intermingling of crops. Oats was an exception in the southern area, where the center of oats production lay 1° N. of that of barley and on the rolling Plains below the High Plains caprock in elevation. Rolling topography was indicated for oat areas by a mean slope of 2.61 percent. (See table 3.)

Behavior of moisture accumulation in relation to elevation was inconclusive and generally nonsignificant. Yields of wheat in the northern and central areas and barley in the central Plains were favorably affected by increasing elevation, whereas corn yield in both northern and central areas and wheat yield in the southern Plains were adversely influenced.

Steepness of slope (*S*) on cultivated land increased from south to north (table 3). Maximum slopes were about the same in all parts of the Plains, but the acreage of steeper sloping land in crops was much larger to the north. Mean slopes averaged a little over 3 percent in the northern area, 2 percent in the central, and 1⅔ percent in the southern. Coefficients of variation were smallest in the central Plains and largest in the southern. Fields were recorded for the prevailing slope where minor irregularities occurred.

Moisture accumulation was generally enhanced in the northern area and depressed in the southern Plains as slope increased in steepness. No apparent consistent relationship was noted for yield and steepness of slope.

Topsoil texture (*ST*) was least variable in the central Plains. Coarser textured lands were used for corn production in the northern and central areas, for oat production in the northern and southern Plains, and notably for sorghum production in the southern area.

In general, moisture accumulation was enhanced by coarser textured soils, irrespective of area. Again, no consistent effect on yield in relation to soil texture was observed.

Topsoil color (*TC*) was coded 1, light brown, to 5, black. Color corresponded roughly with topsoil organic content and darkened generally from south to north with decreasing temperature or west to east with increasing rainfall. Oats were grown on slightly darker soils in the central and southern areas. Oats and corn together occupied the darker soils in the northern Plains. Color variability within a crop area was not large in the northern area, but in the southern Plains it rose sharply, particularly in groups with the greater variation in altitude.

Moisture accumulation was generally favored in the northern area only by darker soil color. No major effect on yield was apparent for this factor.

Erosion removals (*ER*) during the period of preparation were rated 0 for no erosion, to 4 for very severe erosion. Length of preparatory period was positively related to amount of topsoil removed by erosion on oats, barley, and sorghum lands in the central area. Elsewhere the simple correlation was negative or nonsignificant.

Rate of erosion was significantly higher on lands of poorer capability rating in 12 out of 13 crop areas of the Great Plains. It was more strongly and consistently linked with coarseness of topsoil texture and steepness of slope than with most other factors recorded.

Simple correlation coefficients with erosion ran generally higher for slope than for texture, especially in the central and southern areas. This reiterates a point brought out in erosion studies of the old Dust Bowl [4] that a very substantial amount of total soil erosion in the Great Plains was caused by surface water action even in those areas where wind erosion is most spectacular.

No consistent regressions for either moisture accumulation or yield on erosion removals were apparent.

Erosion accumulations (*EA*) were negligible except in the central area, and frequency was not high there. Accumulations usually occurred in fields that were also affected by erosion removals and did not cover large areas. Net effects of erosion accumulations, both on moisture accumulation and on crop yields, were not outstanding. Where erosion accumulations proved significant to moisture or to yield, the relationships were negative, with one exception.

Total rain for the preparatory season (*TR*) was recorded for the open part of the total preparatory period, and excluded the frostbound period, which was compiled separately as factor *WP*. Rainfall varied not only according to time (from year to year) and place (from field to field) but also according to length of period and season of the year. All preparatory seasons were comparable, except for winter wheat, in that they extended from harvest of the previous year's crop to spring or summer planting the following year.

The longest preparatory period average in the central Plains was for grain sorghum planted in late spring, usually after a small-grain crop harvested the summer before. This particular period

[4] FINNELL, H. H. LAND USE EXPERIENCE IN SOUTHERN GREAT PLAINS. U.S. Dept. Agr. Cir. 820, 19 pp., illus. 1949.

averaged 13.36 inches of rain, the highest recorded. Central and southern area row crops, corn and sorghum, as a group utilized the longest and wettest preparatory periods to be found in the Great Plains in regular crop sequences without summer fallow. Variability of seasonal rain was least in the northern area. The highest coefficients of variation, observed for amounts of preparatory season rainfall for oats and barley in the central area, were not entirely due to meteorological vagaries. Length of preparatory period varied more in these instances than for all other spring-planted crops, because the crop sequence in the central Plains farming areas was mixed. Spring grains frequently followed row crops as well as small grains.

No consistent relationship of this factor to moisture accumulation or yield was evident, although a general trend toward positive regression was observed. This merely confirms the fact that increasing the interval between crops, and consequently the total rainfall, does not necessarily improve either moisture storage or yield.

Winter moisture (WP), recorded while soils were frozen, was considered as a separate segment of the total supply. It was of some consequence in central and northern areas but dwindled to a trace in the southern Plains. Means for the northern, central, and southern areas were 1.45 inches, 0.72 inch, and 0.01 inch, respectively.

Winter precipitation generally depressed moisture accumulation and yield alike in the central and southern Plains and gave indications of increases in certain cases in the northern areas.

All precipitation between crops (P), seasonal and winter components, were combined. Variations in the grand total of moisture supply were usually less than observed for separate fractions making up the total.

Both increases and decreases in moisture accumulation resulted from increasing total precipitation during preparation. In the few cases of significant effect on yield, the regression was negative.

Weekly rainfall average (WR). Because of the wide range of length in active preparatory periods, the totals under TR were reduced to weekly averages in order to have some idea of the relative rate of rainfall prevailing while subsoil moisture supply was being accumulated. The seasonal rainfall means did not vary drastically between crops or areas except for winter wheat, where summer rainfall was more substantially involved.

Increasing rainfall per week in nearly every case improved moisture accumulation as expected. No benefit to yield was noted, however, and, in fact, some negative regressions were apparent. This may indicate occurrence of some other production factor, such as fertility, which limits yield under conditions of high rainfall and short preparatory seasons.

Size of rains (I), derived from the number of days of 0.01 inch of precipitation or more, to produce the seasonal amount, TR, provides one measure of the character of rainfall.

Through the northern and central areas size of rain did not differ drastically among the preparatory periods for spring-planted crops, but it was appreciably higher for fall-sown wheat for central and southern areas.

In the southern region the size of rain was characteristically larger for all crops, suggesting that an important part of the total moisture supply came to this area in the form of quickly passing thunder showers.

Response of both yield and moisture accumulation to this factor was inconclusive. Both positive and negative significant regressions were noted.

Length of preparatory period (L) was recorded in weeks. In the northern area where there was little time to spare between harvest and frost or between spring thaw and planting, the length of preparation ranged from 19 to 21 weeks, with relatively small variation. The average time devoted to preparation in the central and southern Plains was somewhat greater, and with more variation. Winter wheat in the southern area constituted one striking exception, inasmuch as planting wheat after wheat, a common practice, cut the preparation period back to the short space between harvest and fall seeding.

Moisture accumulation was generally enhanced in the central area and depressed in the northern Plains by longer preparatory periods. Yield, however, was depressed where significant relationships were observed.

Mean temperature (T) of the preparatory season naturally did not correspond to the annual means of the latitudes and altitudes represented, because the preparatory periods for different crops occurred at different seasons of the year (table 6). However, they do show the conditions during which seeding date soil moisture was stored. Temperature means for different crops in the northern area are very close together, because all crops were spring planted. In both central and southern areas, preparatory period temperature for winter wheat stands out as the exception. A variety of crop sequences in these areas makes the length of preparatory period more variable, which changes mean temperatures for the different period lengths.

Moisture accumulation was generally adversely affected by increased preparatory period temperatures in the central and southern Plains. This may indicate lack of efficiency in storage of moisture on fallowed land or may result from low

storage efficiency in seasons of high temperatures or both. No consistent effect on yield was noted.

Total tillage (*D*) by all methods was summed for a measure of intensity of cultivation during the soil moisture accumulation period. By this yardstick the areas of most intensive cultivation in the Great Plains were the wheat and sorghum lands of the central area, followed closely by the wheat lands of the southern Plains.

Increases in the amount of preparatory tillage favored soil moisture accumulation on central area barley land and southern area sorghum land. It was adverse on wheatland. As to yields, the gross amount of tillage was nonsignificant except in the central area where excessive tillage accompanied reduction of oats and barley yields but favored corn.

In a number of instances favorable reaction has appeared significant for various methods individually which, when included in the total of all tillage, contributed to an adverse effect from excessive amounts of soil stirred during preparation.

Tillage interval (*TI*) between operations varied most in the central and southern areas. Average frequency of tillage was greatest for wheat in all three areas. Variability in timing was smaller in the northern Plains than that of total amount of soil stirred. The opposite was true in the central and southern areas. This would seem to indicate more regularity in the northern Plains in deciding the proper time for tillage.

Moisture accumulation was generally increased by an increased interval between tillage operations. Yield behavior was mixed; both positive and negative significant regressions were observed.

Moldboard tillage (*DM*) included that performed by single or double moldboard plow or lister, and the total for a preparatory season was indicated by the sum of the depths of soil stirred by all such tillage operations for that period. The large coefficients of variation found in certain parts of table 7 will be recognized as derived from large numbers of fields in a group in which moldboard tillage was replaced entirely by other methods.

Soil, seasonal, and weed control requirements have most to do with the selection of tillage implements, but it must be recognized there is an element of tradition present in many places. These comments will apply in like manner to the next four subheadings.

No conclusive relationships between either moisture accumulation or yield and plow tillage were noted.

Disk tillage (*DD*) included all manner of disk implements, but principally the one-way disk, tandem disk, disk-harrow, disk-plow, and disk-cultivator. This type of tillage was more widely used during 1947–51 in the Great Plains than any other. In the northern and southern areas its use significantly reduced the stubble mulch left on the surface at the completion of preparation. Although used as much or more in the central Plains, the simple correlation coefficients do not show much effect on stubble mulch. Using the one-way disk only on heavy stubble or adjusting machines to leave the most residue on the surface may explain this observation.

As with moldboard plowing, no consistent relationships were noted for yields or moisture accumulation.

Chisel tillage (*DCh*) referred mostly to newly designed implements intended to stir the soil without turning it, thus leaving a maximum of crop residues on the surface. The means and coefficients of variation in table 7 will indicate this idea was just being introduced during the period of record, largely in the central and southern areas. It had not had a thorough trial at the time of this report.

As with moldboard plowing, no consistent relationships were noted.

Cultivation (*DCu*) by sweep, blade, small shovel, spike, or rod implements were lumped together to represent shallow stirring of the soil. It was used most widely in the central region and was typified best by the field cultivator.

Conservation practices (*C*) designed to save moisture were coded by an estimated possibility of adding to the soil moisture store, and each field scored according to the combination of practices in effect during preparation. (See footnote 1 to table 2.) Most fields recorded were farmed without special water conservation practices. The average degree of conservation practice was higher in the northern and southern Plains than in the central area. In all areas it was lower on wheatland than the average for other crops.

Moisture accumulation, as expected, was generally enhanced by conservation practices as coded. A general trend toward yield improvement was also noted where such practices were imposed.

Degree of stubble mulching (*M*) accomplished was measured by the amount of crop residue remaining on the surface at the end of preparation. Visual rating according to the code, 0, burned off, to 4, abundant, gave a Great Plains average, including all crops recorded, of 2.34.

Variation in stubble mulching was slightly higher on wheatland than other croplands in all regions. Differences in mean values between crops were not great anywhere in the Plains, and the average variation was only slightly smaller in the southern area than elsewhere.

Where significant effects were noted, increased surface residues generally improved moisture storage but it depressed yields. This is in substantial agreement with other published work.

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Weed growth during preparation (*W*) was estimated at the end of preparatory period from weeds standing and residues of weeds killed according to the code 1, little or no weeds, to 4, heavy weed growth. The Great Plains average by this rating was 1.49.

Weed growth during preparation was above average in the southern area. It was no better controlled on wheatland generally than the average for all crops despite the heavier tillage expenditure, but for the all-crop average in the central area weed growth was less, in keeping with somewhat more intensive cultivation.

Increased weed growth during preparation generally depressed moisture accumulation, particularly in the northern and central areas. Effects on yield were not marked, but a trend toward increases in yield with increased weed growth during preparation was evident.

Weed growth in competition with the growing crop (*WH*) was rated at harvesttime on each field. Growing season weediness increased steadily from south to north excepting for sorghum and winter wheat. Central Plains farmers, with a record of more intensive preparatory tillage, had fewer weeds at harvest of both wheat and grain sorghum than the southern area farmers. Differences in weed growth in comparable crops may be due to the particular weed species prevalent at different latitudes.

Only oats, barley, and corn were comparable between northern and central areas in respect to weediness. Here, again, farmers in the central area, where tillage totals exceeded those of the northern area in growing the same crops, recorded less weediness both before and after planting.

Variations in crop weediness increased noticeably toward the south, showing wider differences between individuals in effectiveness of weed control.

With one exception (oat yields in the northern area) yields were depressed by competition from weeds in the growing crop.

Moisture-storage efficiency (*ME*) observed at the end of preparation was measured by calculating inches of soil moisture penetration per inch of preparatory period precipitation. Local variation in moisture efficiency was least on the dark-colored soils growing oats in the northern area. Moisture efficiency for other crops in the northern area and for all crops in other areas recorded relatively greater averages of variation because of numerous operational as well as natural factors entering into its determination.[5]

In all cases and as expected, moisture accumulation was enhanced by improved efficiency of precipitation storage. Again, however, each significant response in yield was negative, indicating possibility of yield limitations due to other management factors associated with greater efficiency of storage.

In tables 10 and 11 the factor *ME* was omitted as an independent variable because it had not been used in a preliminary or pilot study which was later embodied in this more comprehensive report.

Initial soil moisture store (*IM*) was observed at the end of preparation on each field and recorded as depth of penetration. Mean depths for four crops in the northern area averaged 30.69 inches, in the central Plains for five crops, 33.54, and in the southern area for four crops, 31.74. Corresponding total water supplies were respectively 9, 11, and 10 inches, approximately.

Variation in initial moisture was least on northern area cornland. The most severe variation to be found was on southern area wheatland, a fact borne out by the long-time production record of the southern Plains.

As expected, yield generally increased with increased initial store of soil moisture. One notable exception is the negative regression on cornland in the northern area. Responses were most consistent in the central region.

Time of seeding (*SD*) was recorded to the nearest week and coded as the number of weeks from January 1.

In the northern Plains average dates for oats and barley came in the 16th week, followed in 2 weeks by wheat, which was followed in slightly less than 2 weeks by the planting of corn. In the central area average time for seeding oats was in the 14th week, followed by barley and corn at irregular intervals, ending with grain sorghum, usually in the 22d week. In the southern area seeding started with barley in the 11th week, oats in the 12th, and ended with grain sorghum in the 22d week.

Farmers seem in much better agreement on winter wheat seeding and grain sorghum planting dates than for the other crops. These coefficients of variation were below 10 in both regions.

Significant effects due to planting date were observed only on small grains. Consistent effects were noted only in the northern area, where yields were favorably affected by later planting of these crops.

Yields of grain (*Y*) were recorded in hundredweight per acre for grain sorghum and in bushels per acre for all the other crops.

The northern area recorded the highest average yield of oats, barley, and corn, and the central area was highest in wheat and sorghum. Stability of production by areas and crops was also a point of interest. Reliability of yield increased from south to north, with coefficients of variation by areas, respectively 85, 70, and 48 percent.

Least variation of yield was observed for barley in the northern area, by wheat in the central area, and by grain sorghum in the southern area.

[5] See footnote 3.

Uniform Plains, Area, and Crop Factors

No single factor significantly affected yield (*Y*) of all crops in all areas, although weed growth in the crop depressed yield in all cases except that of oats in the northern areas.

Moisture accumulation (*IM*) was uniformly influenced only by moisture-storage efficiency (*ME*), which, as previously mentioned, should be inherently true. Preparatory period rainfall per week (*WR*) was positively related to moisture accumulation, except for oats in the northern and southern areas. Weed growth (*W*) was generally depressing and water conservation practices (*C*) generally beneficial to moisture storage (*ME*). This general failure of any single factor to dominate is not surprising and serves to demonstrate the complexity of the climatic-soil-plant-operational variables. If regional behavior is considered, only topsoil color (*TC*) consistently affected soil moisture accumulation (*IM*) on all croplands in the northern area in addition to the four mentioned previously. In the central area, lower temperatures (*T*) during preparation, in addition to the four previously discussed, increased the soil moisture store. Surface soil texture (*ST*) produced significant effects in four of the five crops. In the southern area no additional factor was recorded, either operational or natural, that reacted alike on all four croplands in affecting soil moisture accumulation.

Multiple Correlation Coefficients

The magnitude of the multiple correlation coefficients indicates that some other factor or factors not assessed in this study had appreciable effects on moisture storage during preparation and that such factors may be in some way associated with ending the preparatory period immediately after the winter season. For instance, *R* values for moisture accumulation range from approximately 0.59 for oats and barley in the southern area to 0.87 and 0.88 for sorghum in the southern and central areas, respectively. Values were noticeably lower for spring-sown small grains and corn in the northern area than for summer row crops or winter wheat. R^2 values, which indicate the approximate fraction of the variance accounted for by the variables included, ranged from 0.35 to 0.52 for spring-sown small grains and corn in the northern area, and from 0.65 to 0.77 for other crops.

Multiple correlation coefficients were generally lower for yield than for moisture accumulation, probably as a result of failure to include growing season climatic factors in the analysis. It is well known that these factors have major effects on crop yields. No consistent overall difference in these values was noted by area or by type of crop. *R* values ranged from 0.43 for corn in the northern area to 0.66 for wheat in the central area. The corresponding range in R^2 was 0.18 to 0.44, which is the general range observed in other similar studies in the Great Plains, and points up again the importance of growing-season factors.

Consistent with the decline in uniformity of moisture relations from north to south was the increase in variation of the amount of soil-stored water with which crops began their growth from north to south. Consequently average coefficient of variation of yield was 48 percent in the northern area, 70 percent in the central area, and 85 percent in the southern area.

As to yield by areas, only water conservation practices in the southern area and the extent of weed growth uniformly affected yields. Initial soil-moisture storage favorably affected all crop yields except oats in the central area.

No uniform relationships in addition to those listed above were apparent for groups of similar crops as they behaved in the three areas. For individual crops, the following additional factors were observed:

(1) Wheat yields increased as latitudes came closer to the Pole;

(2) Wheat yields were depressed with higher temperatures;

(3) Barley yields increased as stored soil moisture increased;

(4) Corn yields were reduced by higher altitudes and higher erosion accumulations;

(5) Moisture storage for wheat was reduced by frequent tillage;

(6) Coarse-textured lands used for oats and sorghum were best for moisture storage;

(7) Darker colored soils used for cornlands stored more water than lighter colored soils; and

(8) Stubble mulch increased moisture accumulation for cornland.

Summary

Average coefficient of variation for all crop yields was 48 percent in the northern area, 70 percent in the central area, and 85 percent in the southern area. This, along with a reduction in general yield level (except for wheat) from north to south, indicates a generally more stable and favorable growing season climate in the north as compared to the south. Weed competition in the growing crop reduced yields without exception in the southern and central areas, the effect tapering off in the northern Plains. The effect of water conservation practices on yields was particularly strong in the south but noticeably declined northward. Except for oats, initial soil moisture storage favorably affected yields in the central area.

Moisture accumulation was generally enhanced

by improved moisture-storage efficiency, by increased preparatory period rainfall per week and by more intense water conservation measures, and was generally reduced by weed growth during preparation. Darker topsoil color in the northern area and lower temperature during preparation and coarser soil texture in the central area resulted in improved soil moisture storage.

Appendix

TABLE 2.—*List of factors under study in dryfarming areas of the Great Plains for the crop years 1947–51, with designated code*[1]

Factor symbol	Factor	Measurement, code, or rating
Al	Altitude	Feet above sea level by 100-foot intervals.
C	Water conservation practices	Degree of intensity index.[2]
	Tillage—	
D	By all methods	Sum of inches of soil stirred.
DCh	By chisel implement	Do.
DCu	By cultivator	Do.
DD	By disk	Do.
DM	By moldboard plow	Do.
EA	Soil erosion accumulations	Soil Conservation Service rating by degrees of severity (0= none, to 4= severe).
ER	Soil erosion removals	Do.
IM	Initial soil moisture at planting	Depth of penetration, inches.
L	Length of preparatory period	Weeks.
La	Latitude	Degrees N.
LC	Land capability	Soil Conservation Service standard rating, I to VII.
M	Stubble mulch	Amount left at seeding time (visual rating, 0= none, to 4= abundant).
ME	Moisture-storage efficiency, preparatory period	Inches soil wetted per inch of precipitation.
	Precipitation: During preparatory period:	
I	Rain per rainy day	Inches.
P	All precipitation	Do.
TR	Total rainfall	Do.
WP	Frostbound period	Do.
WR	Weekly rain	Do.
S	Steepness of slope	Percent.
SD	Seeding date	Weeks from January 1.
ST	Soil texture	Code: 1= clay, to 7= sand.
T	Temperature, mean for preparatory period	Degrees F. by 10° intervals.
TC	Topsoil color	Code: 1= light brown, to 5= black.
TI	Tillage interval between separate operations	Average number of weeks.
W	Weed growth during preparatory period	Visual rating: 1= little or none, to 4= heavy.
WH	Weeds at crop harvest	Do.
Y	Yield of grain per acre	Cwt. for sorghum; bu. for other crops.

[1] Arranged alphabetically, except for precipitation during preparatory period; i.e., idle period between harvest and planting of next crop.

[2] 1=stubble mulch; 2=stripcropping; 2=contour tillage; 3=stubble left standing through winter; 3=terracing; 4=terracing and contour tillage; 5=supplemental irrigation with diverted water; 5=stalks left standing through winter; or 5=freshly broken sod.

TABLE 3.—*Latitude, altitude, topography, and land capability: Mean and coefficient of variation in relation to crop and area, 1947–51*

Area and crop	Latitude (*La*)		Altitude (*Al*)		Land capability (*LC*)		Land slope (*S*)	
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
	° N.	*Percent*	*Feet*	*Percent*	*Rating*	*Percent*	*Percent*	*Percent*
North:								
Wheat	45.86	13	1,846	19	2.57	32	3.04	57
Oats	44.34	9	1,662	20	2.76	38	2.94	51
Barley	44.52	11	1,733	20	2.88	31	3.51	46
Corn	44.13	3	1,629	20	2.78	34	3.04	55
Central:								
Wheat	39.47	9	3,725	26	3.29	35	2.00	45
Oats	39.84	9	3,328	26	3.05	36	2.01	50
Barley	39.60	11	3,857	29	3.49	37	2.09	45
Corn	39.87	8	3,566	29	3.02	40	2.11	44
Sorghum	38.94	8	3,328	26	3.14	36	1.92	50
South:								
Wheat	35.40	23	3,727	27	3.01	30	1.50	63
Oats	35.82	22	2,444	25	2.85	22	2.61	53
Barley	34.90	24	3,296	15	2.42	25	1.19	88
Sorghum	34.91	25	3,888	21	3.27	35	1.37	69

TABLE 4.—*Soil characters—topsoil texture and color, erosion removals and accumulations: Mean and coefficient of variation in relation to crop and area, 1947–51* [1]

Area and crop	Topsoil				Erosion susceptibility			
	Texture (*ST*)		Color (*TC*)		Removals (*ER*)		Accumulations (*EA*)	
	Mean	C. V.	Mean	C. V.	Mean	C. V.	Mean	C. V.
North:	*Code*	*Percent*	*Code*	*Percent*	*Rating*	*Percent*	*Rating*	*Percent*
Wheat	2.09	62	4.45	14	0.10	390	0.05	640
Oats	2.53	58	4.84	8	.09	411	.06	550
Barley	2.11	63	4.77	10	.12	333	.07	443
Corn	2.51	55	4.89	7	.07	457	.05	560
Central:								
Wheat	2.27	37	3.71	23	.48	148	.27	192
Oats	2.41	38	4.04	13	.45	171	.20	255
Barley	2.40	43	3.63	24	.46	161	.15	307
Corn	2.92	46	3.70	20	.70	128	.49	143
Sorghum	2.29	38	3.97	19	.75	125	.55	140
South:								
Wheat	2.14	61	2.60	24	.30	203	.09	389
Oats	2.77	49	2.99	33	.36	167		
Barley	1.50	64	2.92	12	.07	371	.01	800
Sorghum	3.06	55	2.45	28	.46	163	.27	237

[1] See table 2 for index and ratings of soil characters.

TABLE 5.—*Precipitation during preparatory period—seasonal rain, frostbound period, total, average per week, and average per rainy day: Mean and coefficient of variation in relation to crop and area, 1947–51*

Area and crop	Precipitation									
	Seasonal rainfall (*TR*)		Frostbound interval (*WP*)		Total (*P*)		Per week (*WR*)		Per rainy day (*I*)	
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
North:	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*
Wheat	7.38	50	1.41	73	8.73	45	0.35	40	0.32	41
Oats	7.28	41	1.48	61	8.77	43	.36	36	.37	38
Barley	7.38	42	1.47	62	8.91	45	.36	30	.35	37
Corn	8.24	42	1.44	62	9.65	41	.37	35	.38	34
Central:										
Wheat	12.44	47	.13	34	12.53	48	.57	37	.41	34
Oats	7.84	79	.94	71	8.73	72	.29	52	.31	39
Barley	7.44	78	.82	84	8.30	72	.31	58	.29	38
Corn	10.74	48	.80	64	11.48	47	.38	42	.34	32
Sorghum	13.36	48	.90	72	14.20	47	.42	38	.38	31
South:										
Wheat	9.87	51	.01	86	9.83	52	.65	43	.50	32
Oats	11.72	50			11.71	50	.34	41	.46	37
Barley	8.55	60			8.61	60	.29	55	.41	39
Sorghum	9.69	54	.03	467	9.65	54	.29	55	.41	36

TABLE 6.—*Length of preparatory period, temperature, amount of tillage, and intervals between tillage operations: Mean and coefficient of variation in relation to crop and area, 1947–51*

Area and crop	Length of period (*L*)		Temperature (*I*)		Tillage (*D*)		Tillage interval (*TI*)	
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
North:	*Weeks*	*Percent*	*° F.*	*Percent*	*Inches*	*Percent*	*Weeks*	*Percent*
Wheat	20.10	39	46.74	15	6.36	82	13.16	50
Oats	19.08	22	47.70	11	4.07	98	15.72	36
Barley	19.27	28	48.00	12	4.17	93	15.69	37
Corn	21.26	20	45.09	11	4.49	103	16.97	39
Central:								
Wheat	22.09	47	60.58	10	12.36	51	6.55	71
Oats	23.36	44	48.40	14	6.95	78	13.41	49
Barley	22.16	42	48.80	17	6.95	79	12.71	50
Corn	27.31	25	45.26	11	6.05	67	18.20	48
Sorghum	30.11	31	47.21	11	10.41	67	12.63	65
South:								
Wheat	15.37	41	68.68	7	9.81	49	5.61	61
Oats	32.15	27	52.50	15	6.45	50	19.54	41
Barley	27.76	31	50.60	17	5.56	65	18.93	38
Sorghum	33.04	22	46.10	14	6.49	54	21.63	45

TABLE 7.—*Tillage operations—by moldboard, disk, chisel, cultivator-type implements: Mean and coefficient of variation in relation to crop and area, 1947–51*

Area and crop	Depth							
	Moldboard (*DM*)		Disk (*DD*)		Chisel (*DCh*)		Cultivator (*DCu*)	
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
North:	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*
Wheat	1.58	171	2.63	113	0.17	682	1.98	156
Oats	.88	246	2.25	95	—	—	.09	1,778
Barley	.72	276	2.55	94	.02	1,550	.91	202
Corn	1.71	148	2.19	127	.05	920	.59	283
Central:								
Wheat	1.26	195	6.38	61	1.28	201	3.47	128
Oats	.77	270	3.58	80	.62	316	2.00	176
Barley	.77	293	3.59	75	.65	269	2.06	169
Corn	1.23	168	3.58	66	.65	271	.59	352
Sorghum	1.09	211	4.82	77	1.80	189	2.70	146
South:								
Wheat	.47	342	5.86	59	1.65	179	1.84	178
Oats	1.14	211	4.02	66	.83	248	.42	293
Barley	.18	561	3.45	76	1.56	180	.32	406
Sorghum	2.71	102	1.69	148	1.15	216	.96	193

TABLE 8.—*Cultural conditions—water conservation practices, stubble mulching, and weed growth during preparatory period and during crop season: Mean and coefficient of variation in relation to crop and area, 1947–51* [1]

Area and crop	Water conservation (*C*)		Stubble mulch (*M*)		Weed growth			
					Preparatory period (*W*)		Crop season (*WH*)	
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
North:	*Index*	*Percent*	*Rating*	*Percent*	*Rating*	*Percent*	*Rating*	*Percent*
Wheat	1.27	127	2.14	44	1.41	55	2.47	38
Oats	1.61	119	2.39	33	1.52	59	2.90	22
Barley	1.66	119	2.40	33	1.56	60	2.85	26
Corn	1.57	113	2.35	43	1.26	52	2.68	24
Central:								
Wheat	.60	205	2.34	42	1.53	48	1.73	49
Oats	.66	214	2.34	36	1.22	44	2.11	42
Barley	.58	205	2.39	37	1.32	44	2.11	42
Corn	.63	200	2.61	34	1.35	46	2.16	40
Sorghum	.59	229	2.32	38	1.46	46	1.96	43
South:								
Wheat	.81	191	2.21	39	1.73	46	1.79	46
Oats	1.37	143	2.03	35	1.65	53	1.67	54
Barley	1.56	141	2.59	25	1.49	54	1.66	56
Sorghum	1.18	145	2.31	32	1.92	37	2.09	36

[1] See table 2 for index and ratings of cultural conditions.

TABLE 9.—*Moisture-storage efficiency, soil moisture at planting, date of planting, and yields: Mean and coefficient of variation in relation to crop and area, 1947–51*

Area and crop	Preparatory period				Date of planting (*SD*)		Yield per acre (*Y*)	
	Moisture efficiency (*ME*)		Soil-moisture storage (*IM*)					
	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
North:	*Inches*	*Percent*	*Inches*	*Percent*	*Weeks*	*Percent*	*Cwt.*	*Percent*
Wheat	4.39	68	33.17	46	17.57	35	15.82	48
Oats	3.81	55	29.05	40	15.64	14	31.45	50
Barley	3.97	58	30.85	42	15.44	14	22.98	47
Corn	3.60	83	29.68	34	19.21	19	21.83	49
Central:								
Wheat	3.24	65	35.35	48	33.96	7	20.22	60
Oats	4.82	71	31.04	48	13.28	17	24.85	74
Barley	4.75	75	29.48	53	14.89	36	17.02	82
Corn	3.58	63	35.55	43	19.93	10	19.41	67
Sorghum	2.95	59	36.28	39	22.02	6	12.43	68
South:								
Wheat	3.27	68	29.37	56	35.02	8	11.57	89
Oats	3.57	94	32.84	48	11.41	63	16.78	88
Barley	4.59	95	28.13	46	10.99	76	16.25	94
Sorghum	4.74	64	36.65	47	21.64	9	9.79	71

TABLE 10.—*Wheatlands: Factors affecting soil-moisture accumulation (IM) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=2,652; R=0.7272)		Central area (n=2,079; R=0.8550)		Southern area (n=3,567; R=0.8597)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.054	0.035	−0.202**	−0.045**	0.048	0.014
La	.356**	.279**	.142**	−.011	.025	.014
Al	.186**	.011	−.109**	−.029	.010	.022
T	.209**	.006	−.272**	−.082**	−.140**	.014
TC	−.138**	.100**	.145**	.023	−.057	−.005
ST	.034	.015	.095**	.012	.117**	.057**
S	.025	.037	−.066*	.026	−.023	−.019
ER	.072*	.006	−.047	−.067**	−.014	−.034**
EA	.059	.025	−.023	−.014	.063*	−.008
L	.191**	.035	.489**	.286**	.299**	.050
DM	.113**	.137	.082**	−.013	.108**	.134**
DD	.150**	.254**	.122**	−.001	.208**	.310**
DCh	.083**	.088**	.109**	−.024	.119**	.235**
DCu	.291**	.264**	.158**	.046	.130**	.274**
D	.334**	−.160	.263**	−.028	.346**	−.276*
TI	−.275**	.130**	.171**	.049*	−.090**	.078**
W	−.166**	−.089**	−.144**	−.040**	−.205**	−.071**
C	.057	.081**	.096**	−.014	−.052	−.036**
M	−.146**	−.011	−.010	.053**	−.211**	−.004
TR	.380**	−.108*	.592**	.071	.539**	.413**
WR	.372**	.219**	.171**	.179**	.379**	.117**
I	.027	.018	.125**	.021	.186**	.031**
WP	−.015	−.003	.190**	−.117**	.117**	−.079**
P	.356**	.514**	.595**	.517**	.538**	.133
ME	.466**	.644**	.294**	.624**	.495**	.639**

[1] *=Significant at 5-percent level; **=significant at 1-percent level.

[2] See table 2 for definitions of factor symbols.

TABLE 11.—*Oatlands: Factors affecting soil-moisture accumulation (IM) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=670; R=0.6281)		Central area (n=521; R=0.6856)		Southern area (n=295; R=0.5895)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	0.074	−0.106*	−0.321**	−0.186**	0.005	0.038
La	−.048	.140**	−.060	−.073*	.253**	.218**
Al	−.031	.029	−.311**	−.117*	−.107	.125
T	−.146**	.017	.150**	−.356**	−.022	−.207**
TC	.163**	.174**	.177**	.063	−.076	.009
ST	.150**	.155**	.116**	.226*	.245**	.169*
S	.101**	.223**	−.128**	−.026	.045	−.216*
ER	.208**	.180**	−.030	−.009	.341**	.322**
EA	.194**	−.074	.040	.006		
L	−.108**	−.421**	.329**	.290*	.203**	.218
DM	−.076*	−.116	.088*	−.049	.149**	−.082
DD	−.044	.159	.155**	−.166	.078	−.112
DCh			.117**	−.043	.030	−.184
DCu	.040	.217*	.177**	−.105	.197**	.055
D	−.046	.322	.272**	.295	.238**	.238
TI	.046	.365**	−.017	.058	−.047	.038
W	−.199**	−.204**	−.302**	−.106**	.095	.039
C	.258**	.213**	.080	.120**	−.042	.145*
M	.112**	.005	−.158**	.007	−.107	.010
TR	.259**	.428**	.461**	−.078	.358**	−.203
WR	.401**	.149	.452**	.288**	.343**	.265
I	−.052	−.102**	.289**	−.048	.223	.028
WP	.011	.089**	.199**	.054		
P	.188**	−.084	.474**	.274	.359**	.122

[1] *=Significant at 5-percent level; **=significant at 1-percent level.

[2] See table 2 for definitions of factor symbols.

TABLE 12.—*Barley lands: Factors affecting soil-moisture accumulation (IM) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=483; R=0.6802)		Central area (n=621; R=0.6779)		Southern area (n=498; R=0.5927)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	0.048	−0.087	−0.267**	−0.230**	0.039	0.071
La	.041	.200**	−.025	−.077	.232**	.242**
Al	.022	.202**	−.163**	−.006	−.254**	−.328**
T	−.134**	−.010	−.014	−.357**	.093*	−.298**
TC	.080	.315**	.115**	.105	−.013	.030
ST	.043	.068	.124**	.182**	.167**	.023
S	.147**	.153**	−.059	.087*	.064	−.269**
ER	.206**	.066	−.049	−.001	.223**	.154**
EA	.195**	.048	.016	.032	.023	−.050
L	−.038	−.186*	.302**	.044	.138**	.031
DM	.025	−.173	.132**	−.034	.100*	.007
DD	−.070	−.140	.145**	−.161*	.065	−.012
DCh	.050	.064	.092*	−.112*	.147**	.153
DCu	.004	−.004	.017	−.323**	.000	−.058
D	−.018	.533	.159**	.457**	.213**	.165
TI	.124**	.267**	.094*	.121*	−.118**	−.012
W	−.298**	−.262**	−.253**	−.056	.163**	.130**
C	.302**	.258**	.142**	.156**	−.052	.098*
M	.157**	.119**	−.035	.023	−.120**	.042
TR	.262**	.328**	.452**	.055	.348**	−.066
WR	.369**	.206**	.427**	.190*	.336**	.232*
I	−.088*	−.119**	.210**	−.081*	.207**	−.028
WP	−.059	.028	.107**	−.107*	.061	.053
P	.166**	−.031	.456**	.446	.357**	.261

[1] *=Significant at 5-percent level; **=significant at 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 13.—*Cornlands: Factors affecting soil-moisture accumulation (IM) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=1,059; R=0.6580)		Central area (n=623; R=0.8080)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	0.201**	0.004	−0.251**	−0.084
La	−.213**	−.019	.209**	−.067
Al	−.001	.031	−.339**	−.106
T	−.134**	−.013	−.060	−.267**
TC	.212**	.174**	.302**	.113**
ST	.110**	.041	.056	.183**
S	.180**	.109**	−.091*	−.024
ER	.195**	.016	−.003	.046
EA	.216**	.036	−.016	−.108*
L	.129**	−.127*	.126**	.099
DM	.018	−.057	−.154**	.042
DD	.043	.003	−.069	−.009
DCh	−.013	.000	−.184**	.006
DCu	−.050	−.035	.048	−.018
D	.024	.183	−.174**	.046
TI	.045	.077	.319**	.172**
W	−.091**	−.076**	−.096*	−.013
C	.154**	.134**	.118**	−.013
M	.045	.109**	.124**	.103**
TR	.480**	.134	.465**	.083
WR	.556**	.295**	.483**	.180*
I	.025	−.146**	.132**	−.040
WP	.098**	−.057	.164**	−.085*
N	.455**	.314	.469**	.452
ME	.144**	.284**	.332**	.491**

[1] *=Significant at 5-percent level; **=significant at 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 14.—*Sorghum lands: Factors affecting soil-moisture accumulation (IM) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Central area (n=431; R=0.8807)		Southern area (n=1, 578; R=0.8714)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.246**	0.017	0.296**	0.111**
La	−.126*	−.017	.235**	.103**
Al	−.236**	−.046	.080*	−.031
T	.136**	−.129**	−.405**	−.205**
TC	.102*	−.051	−.080*	.017
ST	.169**	.099**	.319**	.095**
S	−.060	−.019	.132**	−.026
ER	−.155**	−.312**	.083**	.023
EA	−.183**	.018	−.050	−.121**
L	.222**	.405**	−.140**	.027
DM	.050	.076	.241**	−.382**
DD	.069	.033	−.165**	−.413**
DCh	.043	.028	−.076*	−.392**
DCu	.100*	.005	.015	−.286**
D	.125*	−.115	.016	.622**
TI	−.003	.027	.020	.006
W	−.206**	−.036	−.029	.001
C	.103*	.012	.022	.030*
M	.025	.001	.157**	.056**
TR	.454**	−.829**	.228**	.284*
WR	.458**	.490**	.242**	.236**
I	.171**	.050	.076*	.054**
WP	.061	−.028	−.029	−.049**
P	.442**	1.199**	.220**	.229
ME	.344**	.726**	.485**	.810**

[1] *=Significant at 5-percent level; **=significant at 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 15.—*Wheat: Factors affecting yields (Y) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=2,652; R=0.5618)		Central area (n=2,079; R=0.6611)		Southern area (n=3,567; R=0.5300)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.093**	−0.042	−0.119**	−0.053*	−0.218**	−0.085**
La	.233**	.071*	.104**	.047*	.100*	.136**
Al	.226**	.087**	.015	.246**	−.229**	−.133**
T	.097**	−.128**	−.039	−.063*	.205**	.125**
TC	−.227**	−.045	.104**	.199**	.047	−.147**
ST	−.008	.014	.047	.017	−.080*	−.067**
S	−.012	.028	.029	.085**	−.004	−.085**
ER	.047	.012	−.246**	−.048*	−.048	.061**
EA	.036	.001	−.303**	−.151**	−.128**	−.085**
L	.052	−.019	.119**	−.245**	−.066*	.039
DM	.028	−.032	−.034	−.066	.000	.004
DD	.050	.032	−.096**	−.063	−.054	.014
DCh	.089**	.049	−.168**	−.117**	−.047	.004
DCu	.273**	.131	.068*	.085	.038	.145
D	.223**	−.056	−.097**	−.015	−.042	−.029
TI	−.237**	−.048	.244**	.109**	.032	.035
W	−.206**	−.128**	−.141**	−.034	−.018	.048**
C	−.008	.015**	.109**	.029	.125**	.074**
M	−.070*	−.006	−.029	−.067**	.003	−.131**
TR	.165**	.789**	.124**	.063	−.203**	−.192
WR	.182**	.067	−.026	−.137**	−.191**	−.190**
I	−.083**	−.105**	.048	.061**	.076*	.106**
WP	−.198**	−.073	−.006	−.095**	−.111**	−.100**
P	.100**	−.688**	.125**	.001	−.201**	.062
ME	.123**	−.057*	.140**	−.100**	.016	−.039
IM	.285**	.076**	.360**	.365**	−.133**	.018
WH	−.343**	−.209**	−.468**	−.345**	−.338**	−.278**
SD	.164**	.157**	.021	.065**	.057	−.049**

[1] *=Significant at the 5-percent level; **=significant at the 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 16.—*Oats: Factors affecting yields (Y) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=670; R=0.4926)		Central area (n=521; R=0.6012)		Southern area (n=295; R=0.6131)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.045	0.026	−0.168**	−0.065	−0.223**	−0.132
La	−.063	−.106	−.035	−.016	−.034	−.037
Al	−.090	.011	−.051	−.039	.064	.157
T	−.271**	−.102*	−.038	−.141*	.127*	−.027
TC	.103**	.031	.111*	.114*	.003	.013
ST	−.037	−.129**	−.173**	−.119**	−.050	−.041
S	−.076*	−.101*	−.148**	−.043	−.202**	−.159
ER	.028	.071	−.086*	.087	.138*	.152*
EA	.002	−.088	−.187**	−.104	—	—
L	−.149**	−.233*	.035	.200	.026	−.281
DM	−.060	−.100	−.060	.301	.074	.193
DD	−.220**	−.101	−.005	.412	.094	.274
DCh	—	—	.043	.382*	.108	.182
DCu	−.122**	.013	.033	.587*	.128*	.162*
D	−.198**	.245	.003	−.947*	.230**	−.110
TI	.203**	.221*	−.002	−.053	−.158**	.094
W	−.231**	−.081	−.002	.051	−.038	.019
C	.048	−.033	−.042	−.027	−.017	.151*
M	.126**	.034	−.043	−.007	−.079	.004
TR	.042	.236	.129**	.220	.284**	.895
WR	.156**	−.088	.209**	.181	.359**	.022
I	.171**	.046	.005	−.082	.178**	.003
WP	−.204**	−.155**	−.053	−.041	—	—
P	−.021	−.035	.117**	−.252	.279**	−.582
ME	.012	−.030	.067	.087	−.056	−.080
IM	.076*	.018	.225**	.093	.265**	.172*
WH	.058	.028	−.494**	−.417**	−.325**	−.301**
SD	.278**	.267**	.051	.028	.178**	.093

[1] *=Significant at the 5-percent level; **=significant at the 1-percent level.
[2] See table 2 for definitions of factor symbols.

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TABLE 17.—*Barley: Factors affecting yields (Y) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=483; R=0.5137)		Central area (n=621; R=0.5453)		Southern area (n=498; R=0.5217)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.091*	−0.090	−0.087*	−0.262**	−0.168**	−0.071
La	.075	−.095	.021	−.041	−.271**	−.268**
Al	−.074	−.082	.131**	.269**	.136**	.087
T	−.094*	−.056	−.196**	−.102	−.061	−.111
TC	−.011	−.046	−.071	.087	.077	−.034
ST	−.124**	−.059	−.056	−.084*	−.111*	.047
S	−.023	−.008	.032	.154**	−.207**	−.049
ER	.074	.134*	.016	.085*	−.085	.029
EA	.011	−.115	.006	−.026	−.062	−.063
L	−.029	.100	−.120**	.067	−.014	−.050
DM	−.005	−.123	−.062	.031	.012	−.007
DD	−.094	−.100	−.081*	.136	−.089*	−.056
DCh	.022	.004	−.143**	−.029	.040	−.050
DCu	−.006	−.013	−.111**	.081	.135**	.136
D	−.058	.146	−.203**	−.313*	.009	−.062
TI	.119**	.102	.103**	−.053	−.020	−.010
W	−.159**	−.068	.107**	.107*	−.084	−.077
C	−.022	−.133**	.056	.047	.228**	.255**
M	.099*	.072	.046	−.152	.018	−.031
TR	.087	−.189	−.037	−.107	−.050	.493
WR	.183**	.206*	.065	.172	.063	.048
I	−.014	−.053	−.078	−.032	.125**	.016
WP	−.252**	−.306**	−.002	−.026	−.010	.058
P	.011	.022	−.035	−.089	.045	−.439*
ME	.063	−.127	.174**	−.029	−.129**	−.265**
IM	.198**	.176*	.167**	.192*	−.008	.192**
WH	−.187**	−.139**	−.378**	−.323**	−.199**	−.237**
SD	.217**	1.234**	−.055	−.030	−.025	.115*

[1] *=Significant at the 5-percent level; **=significant at the 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 18.—*Corn: Factors affecting yields (Y) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Northern area (n=1,059; R=0.4314)		Central area (n=623; R=0.5657)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.151	−0.055	−0.268**	0.004
La	.074*	−.080	.209**	.057
Al	−.216**	−.236**	−.408**	−.484**
T	−.067*	−.107**	.014	−.017
TC	.073*	−.036	.332**	−.107
ST	.030	.093**	−.056	−.005
S	−.133**	.053	−.108**	−.023
ER	−.088**	.096	.029	−.061
EA	−.120**	−.174**	.088*	.122*
L	.023	−.224**	.034	.010
DM	.192**	.132	−.044	−.283
DD	−.007	.014	.128**	−.380
DCh	.038	.044	−.022	−.296
DCu	.072*	−.002	.059	−.391*
D	.128**	−.086	.079	.901*
TI	−.125**	−.087	−.046	.058
W	.037	.101**	−.079	−.004
C	−.055	.020	.071	.033
M	−.137**	−.091*	.132**	.053
TR	.036	1.217**	.082*	.535
WR	−.023	−.314**	.060	−.201
I	−.005	−.024	.130**	.033
WP	−.116**	−.049	.116**	.086
P	.005	−.723*	.081	−.536
ME	−.044	.044*	.101*	.056
IM	−.133**	−.178**	.236**	.151*
WH	−.083**	−.076*	−.246**	−.249**
SD	−.040	−.038	−.107**	−.042

[1] *=Significant at the 5-percent level; **=significant at the 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 19.—*Sorghum: Factors affecting yields (Y) in the Great Plains, 1947–51* [1]

Factor symbol [2]	Central area (n=431; R=0.6124)		Southern area (n=1,578; R=0.5067)	
	Simple correlation coefficients	Standard partial regression coefficients	Simple correlation coefficients	Standard partial regression coefficients
LC	−0.192**	0.016	−0.129**	−0.136**
La	−.202**	−.095*	−.009	−.053
Al	−.146**	.145	−.092**	.065
T	.243**	.015	−.001	−.061*
TC	.076	.115	.078*	−.041
ST	.088	.040	−.104**	.043
S	−.159**	−.093	−.066*	−.087*
ER	.059	−.064	−.091**	.002
EA	.040	.068	−.067*	−.025
L	.223**	−.004	−.011	−.188**
DM	−.000	.120	.090**	−.009
DD	.282**	.212	.069*	.042
DCh	.271**	.210	.249**	.067
DCu	.133**	.090	.124**	.035
D	.357**	−.119	.319**	.299
TI	−.266**	−.172**	−.204**	.129**
W	−.039	.084	−.008	.051*
C	.102*	.099*	.266**	.226**
M	.043	.110*	−.090**	−.081**
TR	.349**	1.992*	.177**	.332
WR	.250**	−.167	.210**	.070
I	.198**	.102*	.047	−.123**
WP	.029	.139	.068*	.087**
P	.334**	−1.871*	.154**	−.211
ME	−.003	−.046	−.067*	−.025
IM	.329**	.260**	.083**	.058
WH	−.246**	−.226**	−.156**	−.217**
SD	.064	.003	−.077*	−.031

[1] *=Significant at the 5-percent level; **=significant at the 1-percent level.
[2] See table 2 for definitions of factor symbols.

TABLE 20.—*Wheat group for northern area* (n=2,652),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	−0.363	0.122	−0.066	0.188	−0.058	0.771	0.205	0.208	0.033	−0.177	0.066	−0.033	−0.048	−0.160
La		.505	.383	−.668	.034	−.137	−.093	−.137	−.217	.180	−.112	.106	.304	.232
Al			.300	−.641	−.150	.237	−.002	.007	−.031	−.102	.030	.074	.222	.109
T				−.311	.033	.053	.010	−.036	.198	.136	.224	.027	.310	.387
TC					−.086	.046	.100	.117	.149	−.051	.084	−.089	−.240	−.138
ST						−.221	.060	−.005	−.154	.107	−.095	−.016	−.052	−.032
S							.195	.201	−.017	−.153	.068	−.008	−.095	−.098
ER								.758	.038	.022	.065	.001	−.029	.032
EA									.051	−.015	.080	−.013	−.055	.002
L										.135	.417	.087	.306	.509
DM											.112	−.012	.174	.555
DD												−.051	−.029	.482
DCh													−.005	.181
DCu														.661
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.062 are significant at P=0.05.

TABLE 21.—*Oat group for northern area* (n=670),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	−0.343	0.036	0.008	0.044	0.382	0.606	0.242	0.201	0.001	−0.225	−0.012	−0.032	−0.108	−0.177
La		.006	.110	−.539	−.300	−.217	−.102	−.119	−.023	.016	−.007	−.002	.066	.080
Al			.149	−.598	.023	.365	.107	.078	−.024	−.227	−.044	.009	.035	−.129
T				−.134	−.081	.109	−.060	−.085	.410	.127	.297	−.019	.124	.274
TC					.222	−.009	.053	.081	.088	.003	.015	.018	−.041	−.004
ST						−.052	.136	.119	−.127	−.024	−.090	.010	−.022	−.072
S							.116	.134	.013	−.238	.006	−.052	−.059	−.154
ER								.867	−.110	−.005	.020	−.011	−.068	−.046
EA									−.099	−.066	.036	−.009	−.086	−.052
L										.251	.535	−.003	.321	.563
DM											.058	−.018	.284	.686
DD												.015	.187	.648
DCh													−.020	−.000
DCu														.649
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.071 are significant at P=0.05.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.203	0.101	-0.064	0.118	0.056	0.038	0.153	0.009	0.051	-0.087	-0.054	0.195	0.110	-0.093
-.406	-.212	.061	-.142	-.182	-.093	-.343	.022	-.163	.364	.356	-.584	-.150	.283
-.195	-.035	-.010	-.042	-.091	-.114	-.235	.084	-.069	.190	.186	-.357	.022	.226
-.327	.097	-.224	-.254	.112	-.005	-.149	-.238	.041	.124	.209	-.180	-.040	.097
.272	.101	-.049	.075	.194	.165	.351	-.004	.182	-249	-.138	.381	.093	-.227
-.048	.000	.071	.033	-.050	.030	-.037	-.103	-.073	.128	.034	.079	-.036	-.008
.106	.078	-.063	.100	.012	.015	.097	-.014	.002	-.005	.025	.061	.120	-.012
.012	-.040	-.025	-.031	.079	.069	-.012	-.124	.041	.012	.072	.076	.078	.047
.026	-.055	-.006	-.021	.080	.061	.018	-.092	.050	-.002	.059	.088	.098	.036
-.019	.146	-.323	-.336	.740	.238	.160	.175	.745	-.375	.191	.017	.172	.052
-.351	-.062	-.208	-.499	.181	.140	-.019	-.035	.165	-.053	.113	-.071	-.079	.028
-.411	.119	-.270	-.207	.354	.146	.067	-.035	.320	-.117	.150	.017	.094	.050
-.121	-.025	-.067	-.052	.068	.016	-.014	.037	.072	.004	.083	-.093	-.001	.089
-.584	-.056	-.190	-.243	.283	.161	.010	-.022	.262	-.005	.291	-.290	.036	.273
-.790	-.002	-.390	-.531	.478	.256	.032	-.042	.439	-.095	.334	-.220	.033	.223
	.044	.274	.383	-.160	-.140	.034	.076	-.130	-.102	-.275	.260	-.003	-.237
		-.101	.062	.134	.073	.032	.053	.141	-.178	-.166	.171	.002	-.206
			.401	-.240	-.084	-.158	.064	-.210	.209	.057	-.024	-.082	-.008
				-.290	-.128	-.046	-.045	-.287	.119	-.146	.092	.004	-.070
					.748	.319	.052	.962	-.379	.380	.016	.190	.165
						.352	-.078	.691	-.247	.372	.008	.088	.182
							.007	.300	-.215	.027	.117	.115	-.083
								.311	-.244	-.015	-.063	.020	-.198
									-.430	.356	-.001	.183	.100
										.466	-.220	-.027	.123
											-.337	.030	.285
												.042	-.343
													.164

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.017	0.004	-0.004	0.092	0.020	0.027	0.112	0.011	0.016	0.030	0.074	0.042	-0.062	-0.045
-.175	-.014	.000	-.013	-.274	-.221	-.306	.087	-.122	.183	-.048	-.422	.257	-.063
.062	.008	.056	-.008	-.128	-.168	-.065	.165	-.038	.088	-.031	-.178	.028	-.090
-.144	.267	-.197	-.253	.093	-.206	-.076	.095	.088	-.078	-.146	-.070	.189	-.271
.060	.002	-.060	.090	.243	.252	.312	-.067	.137	-.124	.163	.300	-.097	.103
.005	-.017	.005	.071	.021	.121	.132	-.001	-.004	.081	.150	.124	-.010	-.037
.142	.076	-.025	.092	-.054	.072	.029	.017	-.034	.098	.101	-.010	-.047	-.076
.037	-.057	.006	-.045	.025	.081	-.048	-.090	-.017	.140	.208	-.047	-.001	.028
.040	-.048	.001	-.037	.048	.120	-.062	-.512	.011	.102	.194	-.004	-.009	.002
-.176	.420	-.316	-.330	.655	.133	.086	.238	.555	-.496	-.108	.098	-.045	-.149
-.442	-.098	-.227	-.507	.171	.004	-.004	.029	.139	-.160	-.076	-.031	.028	-.060
-.530	.393	-.338	-.223	.303	.028	-.083	.140	.272	-.205	-.044	-.020	-.128	-.220
.007	-.026	-.016	.026	-.011	-.013	.073	-.031	-.020	-.012	-.023	.002	.046	.173
-.699	.135	-.226	-.309	.200	.013	-.012	.202	.202	-.096	.040	-.038	-.003	-.122
-.816	.210	-.398	-.523	.358	.030	-.046	.182	.313	-.241	-.046	-.048	-.047	-.198
	-.182	.313	.410	-.109	.029	.063	-.189	-.133	.049	.046	.074	-.003	.203
		-.152	-.059	.251	.050	-.023	.251	.258	-.274	-.199	.109	-.133	-.231
			.421	-.119	.089	-.178	-.084	-.097	.267	.258	-.016	-.120	.048
				-.202	.012	-.024	-.148	-.207	.220	.112	.101	-.048	.126
					.780	.199	.158	.817	-.490	.259	.164	.105	.042
						.225	.039	.624	-.305	.401	.128	.172	.156
							-.003	.130	-.191	-.052	.089	.231	.171
								.369	-.309	.011	-.089	.132	-.204
									-.482	.188	.119	.154	-.021
										.439	.009	-.090	.012
											-.062	.055	.076
												-.127	.058
													.278

TABLE 22.—*Barley group for northern area* ($n=483$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	−0.297	0.243	0.064	0.012	0.080	0.655	0.135	0.182	0.099	−0.246	0.047	−0.019	−0.069	−0.127
La		.244	.177	−.633	−.146	−.186	−.038	−.139	−.276	.174	−.281	.058	.089	−.036
Al			.097	−.647	.011	.254	.056	.027	−.123	−.191	−.162	.047	.077	−.157
T				−.183	.023	.012	.006	−.077	.351	.137	.125	.110	.257	.331
TC					.109	.002	.061	.106	.127	−.012	.249	−.132	−.170	.059
ST						−.176	.097	.095	−.060	.073	−.061	−.006	.034	.014
S							.133	.135	.000	−.222	.048	−.033	−.132	−.138
ER								.757	−.013	.016	.037	−.024	−.055	.005
EA									−.064	−.066	.020	−.019	−.085	−.061
L										.189	.518	.045	.231	.520
DM											−.074	−.029	.290	.584
DD												−.051	.142	.614
DCh													.219	.139
DCu														.699
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.089 are significant at $P=0.05$.

TABLE 23.—*Corn group for northern area* ($n=1,059$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	−0.333	0.352	0.089	0.062	0.218	0.613	0.255	0.289	0.045	−0.107	0.119	0.026	−0.182	−0.053
La		−.220	−.091	−.429	−.225	−.263	−.132	−.141	−.277	.050	−.149	.020	.149	−.006
Al			.228	−.564	.078	.367	.132	.109	.042	−.206	.109	.026	−.045	−.059
T				−.115	−.041	.118	−.131	−.103	.309	.085	.202	−.002	−.081	.148
TC					.145	.037	.052	.056	.074	.129	−.012	−.012	−.137	.013
ST						−.212	.164	.177	−.033	.049	−.071	.017	.045	.008
S							.158	.150	.031	−.122	.107	−.025	−.199	−.077
ER								.862	−.092	−.128	−.015	−.025	−.059	−.100
EA									−.069	−.106	−.024	−.020	−.048	−.090
L										.438	.509	−.011	.150	.602
DM											.232	−.019	.293	.795
DD												−.037	.001	.614
DCh													.048	.084
DCu														.529
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.062 are significant at $P=0.05$.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.159	0.043	-.027	0.051	0.119	0.092	0.123	0.006	0.094	-0.050	0.048	0.064	-0.117	-0.091
-.116	-.151	.104	-.044	-.243	-.127	-.353	.012	-.103	.229	.041	-.386	.444	.076
.047	-.008	-.023	.038	-.159	-.155	-.171	-.129	-.040	.129	.022	-.220	.115	-.074
-.200	.315	-.221	-.222	.163	-.083	-.087	-.071	.099	-.093	-.134	.033	-.001	-.094
.017	.022	-.041	.067	.167	.140	.330	-.045	.071	-.093	.080	.335	-.262	-.011
-.019	.022	-.075	-.071	.030	.035	.011	.008	.003	.054	.043	.167	-.165	-.124
.108	-.021	-.008	.065	.079	.118	.098	-.015	.060	.022	.147	.006	-.081	-.023
.029	-.092	-.011	-.118	.082	.105	-.080	-.115	.034	.064	.206	.119	-.016	.074
.052	-.093	.044	-.061	.052	.118	-.045	-.112	.014	.078	.194	.158	-.040	.011
-.030	.403	-.321	-.289	.728	.280	.169	.266	.594	-.515	-.038	.154	-.042	-.029
-.324	-.034	-.191	-.431	.219	.171	-.088	.001	.166	-.143	.025	.068	.043	-.005
-.488	.343	-.300	-.143	.421	.182	.132	.167	.329	-.290	-.070	.132	-.128	-.094
-.104	.123	.027	-.007	.006	-.045	.006	-.020	-.005	.078	.050	-.056	.071	.022
-.601	.183	-.256	-.183	.187	.056	-.033	.039	.141	-.061	.004	-.027	.069	-.006
-.748	.281	-.391	-.387	.450	.216	.021	.120	.347	-.263	-.018	.085	-.020	-.058
---	.190	.250	.229	-.008	-.021	.024	-.083	-.017	.015	.124	-.016	-.036	.119
---	---	-.219	-.134	.282	.074	.114	.198	.250	-.343	-.298	.119	-.023	-.159
---	---	---	.335	-.219	-.062	-.230	-.069	-.210	.325	.302	-.076	-.033	-.022
---	---	---	---	-.249	-.119	-.013	-.165	-.310	.278	.157	-.062	-.057	.099
---	---	---	---	---	.756	.255	.173	.783	-.478	.262	.141	.057	.087
---	---	---	---	---	---	.279	.076	.588	-.300	.369	.053	.113	.183
---	---	---	---	---	---	---	.211	.214	-.282	-.088	.138	.115	-.139
---	---	---	---	---	---	---	---	.372	-.332	-.059	-.085	.158	-.252
---	---	---	---	---	---	---	---	---	-.457	.167	.064	.101	.011
---	---	---	---	---	---	---	---	---	---	.490	-.220	.004	.063
---	---	---	---	---	---	---	---	---	---	---	-.214	.025	.199
---	---	---	---	---	---	---	---	---	---	---	---	-.275	-.187
---	---	---	---	---	---	---	---	---	---	---	---	---	.217

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.053	-0.018	-0.084	0.006	0.137	0.154	0.169	0.061	0.132	0.032	0.201	0.105	0.003	-0.151
-.097	.072	.115	.077	-.256	-.204	-.278	-.090	-.246	.080	-.213	-.211	-.003	.074
.005	.092	-.075	-.001	.017	-.047	-.033	.075	.021	.134	-.001	-.122	.067	-.216
-.074	.116	-.069	-.171	-.022	-.270	-.100	-.014	-.028	.059	-.134	-.148	-.036	-.067
.077	-.166	-.018	.012	.155	.199	.316	.048	.153	-.189	.212	.199	-.119	.073
.004	-.079	-.051	-.013	.073	.102	.004	.087	.078	-.026	.110	.098	-.036	.030
.057	-.000	-.064	.003	.095	.101	.158	.031	.091	.031	.180	-.012	-.008	-.133
.095	-.057	-.007	-.012	.078	.153	-.037	-.053	.058	.035	.195	.111	-.016	-.088
.096	-.025	.018	-.008	.112	.183	-.038	-.043	.092	.025	.216	.111	-.014	-.120
-.304	.091	-.310	-.446	.697	.293	.113	.397	.700	-.282	.129	-.138	.030	.023
-.645	-.107	-.348	-.539	.361	.171	.058	.242	.377	-.176	.018	-.196	.032	.192
-.600	.064	-.408	-.409	.381	.166	.157	.320	.402	-.136	.043	-.148	.039	-.007
-.038	-.020	-.023	.009	-.025	-.045	-.022	-.012	-.026	.001	-.013	-.019	-.011	.038
-.436	.014	-.106	-.115	.069	-.003	-.123	.073	.075	-.035	-.050	-.119	.029	.072
-.866	-.014	-.465	-.571	.455	.194	.072	.364	.482	-.191	.024	-.256	.053	.128
---	.020	.441	.503	-.262	-.113	-.082	-.311	-.300	.107	.045	.284	-.055	-.125
---	---	.063	.148	.010	-.067	-.067	.106	.032	.020	-.091	-.034	-.019	.037
---	---	---	.443	-.189	-.065	-.192	-.158	-.197	.181	.154	.089	-.016	-.055
---	---	---	---	-.357	-.168	-.040	-.213	-.362	.192	.045	.181	-.015	-.137
---	---	---	---	---	.826	.238	.392	.977	-.306	.480	-.083	.012	.036
---	---	---	---	---	---	.264	.252	.794	-.247	.556	.041	.007	-.023
---	---	---	---	---	---	---	.159	.240	-.180	.025	-.007	-.014	-.005
---	---	---	---	---	---	---	---	.564	-.245	.098	-.169	.017	-.116
---	---	---	---	---	---	---	---	---	-.327	.455	-.109	.017	.005
---	---	---	---	---	---	---	---	---	---	.144	.030	.386	-.044
---	---	---	---	---	---	---	---	---	---	---	.081	.015	-.133
---	---	---	---	---	---	---	---	---	---	---	---	.016	-.083
---	---	---	---	---	---	---	---	---	---	---	---	---	-.040

TABLE 24.—*Wheat group for central area* (*n*=*2,079*),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.003	0.482	−0.217	−0.418	0.063	0.540	0.185	0.041	0.071	−0.018	0.045	0.091	−0.255	−0.121
La		.045	−.214	.168	.363	.102	.064	.050	.197	.140	−.011	.067	.085	.140
Al			−.489	−.672	.043	.049	−.046	−.128	.279	−.044	.065	.123	−.274	−.121
T				.254	−.140	−.011	−.133	−.088	−.704	−.057	−.215	−.298	−.072	−.327
TC					.028	−.093	.014	.081	−.039	.031	−.052	−.041	.120	.051
ST						.053	.070	.050	.108	.042	.015	.052	−.000	.052
S							.132	.000	−.020	.054	−.068	−.026	−.112	−.106
ER								.653	.057	.014	.013	.107	.123	.151
EA									−.001	−.020	.014	.093	.141	.143
L										.145	.325	.355	.126	.494
DM											−.171	.057	.051	.341
DD												−.000	−.190	.411
DCh													.026	.446
DCu														.594
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.062 are significant at $P=0.05$.

TABLE 25.—*Oat group for central area* (*n*=521),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.019	0.406	0.004	−0.215	0.077	0.603	0.121	−0.007	0.024	−0.029	−0.086	0.089	0.036	−0.002
La		.156	−.173	−.078	.304	.055	.127	.130	−.056	−.019	−.044	−.009	−.024	−.051
Al			−.127	−.675	.102	−.012	.015	−.101	.054	−.056	−.205	.098	−.007	−.091
T				.045	−.083	.054	.077	.059	.756	.135	.393	.157	.314	.511
TC					−.133	.028	−.087	−.015	−.107	−.057	.094	−.169	−.062	−.075
ST						−.003	.103	.159	−.070	.074	−.057	.013	−.107	−.068
S							.161	.001	.033	.013	−.006	.016	−.030	−.008
ER								.672	.101	.078	.074	.050	.062	.124
EA									.058	.049	.108	.006	.069	.125
L										.132	.414	.326	.463	.680
DM											−.156	−.030	.113	.357
DD												.049	.041	.505
DCh													.036	.396
DCu														.712
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.084 are significant at $P=0.05$.

1947–51: Simple correlation coefficients [1]

TI	W	C	M	TR	WR	I	WP	P	ME	IM	WH	SD	Y
0.171	0.184	−0.074	0.050	−0.072	−0.170	−0.106	0.105	−0.060	−0.138	−0.202	0.119	−0.076	−0.119
.040	−.022	−.020	−.044	.127	−.093	−.130	.272	.154	.064	.142	−.036	.031	.104
.330	.085	−.223	.086	.007	−.281	−.252	.285	.031	−.169	−.109	.006	−.256	.015
−.307	−.073	.089	.106	−.522	.171	.223	−.440	−.545	.315	−.272	−.007	.251	−.039
−.129	−.100	.186	−.021	.024	.047	.020	−.009	.025	.157	.145	−.028	.160	.104
.046	.013	−.053	.020	.099	−.007	−.077	.150	.112	.013	.095	−.042	−.059	.047
.139	.097	.097	.001	−.071	−.064	.030	.023	−.061	.001	−.066	.052	.038	.029
−.093	.172	−.074	−.114	.142	.184	.029	.015	.137	−.145	−.047	.148	−.059	−.246
−.153	.150	−.080	−.059	.110	.184	.018	−.051	.099	−.095	−.023	.225	−.039	−.303
.333	−.092	−.025	−.175	.778	−.216	−.129	.543	.801	−.310	.489	−.153	−.120	.119
−.070	−.024	−.005	−.298	.172	.060	.081	.278	.185	−.023	.082	−.060	.051	−.034
−.229	−.094	−.105	.004	.286	−.048	−.014	.123	.289	−.163	.122	.008	.050	−.096
−.090	.001	.006	−.059	.298	−.064	−.066	.297	.314	−.145	.109	.047	−.035	−.168
−.360	−.117	.178	−.193	.259	.108	.005	−.115	.237	−.109	.158	−.023	.051	.068
−.463	−.151	.060	−.274	.550	.046	.000	.227	.548	−.247	.263	−.013	.074	−.097
	.108	−.064	.040	.137	−.182	−.098	.162	.151	−.037	.171	−.135	−.202	.244
		−.032	.078	−.054	.131	.004	−.038	−.057	−.101	−.144	.143	.047	−.141
			.027	.064	.115	.096	−.044	.059	.053	.096	−.073	.074	.109
				−.223	−.029	−.017	−.070	−.217	.183	−.010	.047	.022	−.029
					.331	.152	.353	.989	−.400	.592	−.178	−.009	.124
						.464	−.173	.303	−.208	.171	−.043	.086	−.026
							−.145	.133	−.041	.125	−.051	.090	.048
								.421	−.099	.190	−.151	−.144	−.006
									−.393	.595	−.189	−.021	.125
										.294	−.095	−.005	.140
											−.273	−.044	.360
												.034	−.468
													.021

1947–51: Simple correlation coefficients [1]

TI	W	C	M	TR	WR	I	WP	P	ME	IM	WH	SD	Y
0.015	0.315	0.040	−0.015	−0.080	−0.153	−0.182	−0.119	−0.086	−0.200	−0.321	0.057	0.172	−0.169
.027	.077	−.129	.031	−.088	−.083	−.161	−.142	−.105	.056	−.060	.004	.119	−.035
.152	.266	−.047	.065	−.151	−.290	−.363	−.419	−.195	−.035	−.311	−.126	.316	−.051
−.001	.058	.015	−.202	.669	.403	.237	.137	.676	−.519	.150	.070	.054	−.038
−.023	−.134	.055	.076	.028	.152	.255	.382	.068	.029	.177	−.001	−.345	.111
.068	−.043	−.042	.067	−.114	−.134	−.095	−.088	−.120	.249	.116	.103	.085	−.173
.036	.083	.011	−.061	.026	.045	.047	.129	.044	−.205	−.128	.111	.034	−.148
−.043	.019	−.118	−.117	.061	−.036	.067	.026	.064	−.047	−.030	.121	.044	−.086
−.060	−.054	−.070	−.111	.075	−.010	.131	−.014	.073	.041	.040	.263	−.012	−.187
.002	−.035	−.024	−.311	.854	.429	.256	.042	.845	−.516	.330	.083	.126	.035
−.178	−.077	−.071	−.280	.043	−.017	.038	.127	.057	−.009	.088	.028	.088	−.060
−.355	.004	−.062	−.054	.473	.322	.211	.125	.479	−.249	.155	.061	.088	−.005
−.172	.004	.008	−.123	.244	.074	.079	−.031	.236	−.133	.117	.058	.070	.043
−.469	−.071	.007	−.264	.399	.184	.056	−.108	.381	−.189	.177	.104	−.005	.033
−.614	−.080	−.056	−.349	.606	.302	.188	.034	.600	−.299	.272	.133	.101	.003
	.050	.024	.112	−.020	−.009	.045	.004	−.021	−.060	−.017	−.091	−.010	−.002
		−.078	.097	−.033	−.039	−.037	−.178	−.049	−.163	−.302	−.047	.093	−.002
			.151	−.058	−.109	−.036	.023	−.053	.153	.080	.038	−.133	−.042
				−.339	−.246	−.088	.021	−.329	.184	−.158	−.015	−.010	−.043
					.774	.462	.087	.993	−.506	.461	.010	.002	.129
						.541	.147	.776	−.415	.452	−.092	−.052	.209
							.167	.470	−.259	.289	.121	−.018	.005
								.194	−.121	.199	.100	−.095	−.053
									−.515	.474	.024	−.008	.117
										.358	−.042	−.156	.067
											−.055	−.113	.225
												−.004	−.494
													−.051

TABLE 26.—*Barley group for central area* ($n=621$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.151	0.562	−0.035	−0.413	0.168	0.602	0.197	0.133	0.073	0.080	−0.024	0.045	0.063	0.038
La		.112	−.232	.221	.130	.203	.034	.087	.058	.245	−.155	−.066	.235	−.046
Al			−.143	−.766	.213	.180	.104	.144	.037	.067	−.032	.054	−.025	−.090
T				.092	−.093	−.083	.039	−.137	.525	.005	.428	.255	.066	.449
TC					−.184	−.104	−.091	−.124	.028	.017	−.050	−.038	.105	.029
ST						.100	.149	.150	.021	.019	−.061	.032	−.008	−.047
S							.203	.134	.020	.037	−.098	−.023	−.049	−.063
ER								.435	.121	.015	.020	.048	.006	.051
EA									.032	.144	−.030	−.020	.117	−.014
L										.188	.431	.317	.323	.572
DM											−.027	.026	.340	.354
DD												.162	.070	.597
DCh													.105	.480
DCu														.613
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.074 are significant at $P=0.05$.

TABLE 27.—*Corn group for central area* ($n=623$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	−0.432	0.651	−0.025	−0.509	0.187	0.574	−0.027	−0.067	0.161	0.428	−0.152	0.218	−0.041	0.203
La		−.472	.020	.417	.338	−.171	.176	.236	−.160	−.295	.013	−.053	−.056	−.204
Al			−.136	−.791	.306	.231	−.067	−.121	.039	.377	−.198	.214	−.020	.162
T				.133	−.102	.021	−.127	−.145	.606	−.006	.196	.056	.190	.232
TC					−.219	−.235	.016	.110	.005	−.216	.156	−.136	.051	−.050
ST						.213	.151	.148	−.129	.028	−.157	.138	−.024	−.036
S							.063	−.022	.091	.111	−.100	.093	−.055	.009
ER								.810	−.105	−.046	.004	.032	−.027	−.025
EA									−.159	−.026	.053	.001	−.046	−.009
L										.123	.198	.076	.313	.373
DM											−.241	.116	.025	.437
DD												−.196	.176	.458
DCh													.037	.403
DCu														.638
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.082 are significant at $P=0.05$.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
-0.032	0.281	-0.017	-0.028	-0.080	-0.220	-0.181	-0.202	-0.093	-0.138	-0.267	-0.003	0.185	-0.087
.043	.001	.010	-.020	.009	-.163	-.179	-.124	.009	.070	-.025	.061	-.120	.021
.097	.296	-.049	.073	-.036	-.150	-.295	-.272	-.057	-.004	-.163	-.135	.316	.131
-.157	.052	-.039	-.135	.471	.388	.253	-.124	.433	-.454	.014	.077	.420	-.196
-.027	-.238	.051	-.040	.032	.003	.119	.186	.053	.047	.115	.104	-.328	-.071
.083	-.023	.020	-.016	-.064	-.148	-.170	-.158	-.081	.195	.124	.059	.008	-.056
.053	.091	.059	.038	-.068	-.127	-.092	-.018	-.067	-.030	-.059	.033	.053	.032
.022	.071	-.142	-.139	.001	-.113	-.058	.136	.013	-.057	-.049	.035	.014	.016
.075	.026	-.085	-.048	.032	-.118	-.009	.056	.048	.052	.016	.024	-.064	.006
.015	-.012	-.074	-.224	.779	.304	.189	.091	.774	-.425	.302	-.019	.117	-.120
-.102	-.034	-.008	-.183	.270	.062	.091	.095	.306	-.036	.132	-.004	.064	-.062
-.443	.005	-.144	-.012	.497	.378	.241	-.017	.472	-.282	.145	.035	.319	-.081
-.217	.027	-.020	-.073	.305	.154	.131	.064	.303	-.163	.092	-.048	.202	-.143
-.395	.071	.003	-.161	.363	.023	.043	.035	.369	-.094	.017	-.059	-.090	-.111
-.666	-.017	-.084	-.217	.561	.307	.235	.010	.540	.300	.159	-.037	.243	-.203
----------	-.100	.061	.021	-.063	-.114	-.094	.124	-.031	.052	.094	.049	-.167	.103
----------	----------	-.017	.005	-.078	-.094	-.123	-.120	-.085	-.046	-.253	-.112	.133	.107
----------	----------	----------	.204	-.070	-.044	-.010	-.023	-.068	.229	.142	.009	-.008	.056
----------	----------	----------	----------	-.178	-.079	-.045	.023	-.176	.185	-.035	-.032	.018	.046
----------	----------	----------	----------	----------	.724	.426	.123	.984	-.434	.452	-.068	.210	-.037
----------	----------	----------	----------	----------	----------	.559	.057	.705	-.401	.427	-.085	.271	.065
----------	----------	----------	----------	----------	----------	----------	.098	.433	-.285	.210	.064	.075	-.078
----------	----------	----------	----------	----------	----------	----------	----------	.232	-.128	.107	-.011	-.290	-.002
----------	----------	----------	----------	----------	----------	----------	----------	----------	-.436	.456	-.006	.164	-.035
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	.402	-.057	-.206	.174
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	-.098	.008	.167
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1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
-0.062	0.236	-0.043	-0.168	-0.073	-0.201	-0.214	-0.225	-0.093	-0.092	-0.251	0.007	0.091	-0.268
.065	-.183	.026	.245	-.001	.141	-.088	.067	.010	.134	.209	.043	-.090	.209
-.100	.205	-.083	-.190	-.295	-.401	-.381	-.311	-.307	.016	-.339	.004	.126	-.408
.080	.023	-.018	.142	.420	.222	.096	.101	.409	-.332	-.060	.042	.207	.014
.038	-.035	.093	.203	.228	.294	.286	.187	.227	-.006	.302	-.040	-.068	.332
-.027	.032	-.117	.032	-.281	-.255	-.326	-.165	-.283	.305	.056	-.049	.027	-.056
.046	.089	-.012	-.007	.002	-.083	-.033	-.071	-.003	-.053	-.091	-.047	.013	-.108
-.029	.014	-.124	-.074	.002	.061	.265	.068	.015	-.006	-.003	.107	-.076	.029
-.103	.005	-.106	-.005	-.009	.065	.255	.016	-.001	.016	-.016	.102	-.046	.088
.172	.002	.019	-.049	.615	.178	.039	.100	.598	-.371	.126	.005	-.196	.034
-.251	.181	-.031	-.145	-.055	-.148	-.099	-.146	-.072	-.075	-.154	-.034	.129	-.044
-.466	-.084	-.122	.020	.151	.083	.189	.121	.144	-.125	-.069	.031	-.046	.128
-.301	.147	-.056	-.067	-.124	-.221	-.165	-.106	-.126	-.039	-.184	-.018	-.045	-.022
-.266	.014	-.004	-.219	.271	.123	.086	-.013	.259	-.099	.048	-.043	.128	.059
-.672	.127	-.112	-.202	.147	-.060	.030	-.056	.128	-.182	-.174	-.029	.128	.079
----------	-.142	.137	.080	.241	.191	.007	.043	.245	-.013	.319	.019	-.183	-.046
----------	----------	.005	.011	-.027	-.033	-.070	-.106	-.036	-.038	-.096	-.079	.217	-.079
----------	----------	----------	.097	.051	.052	.027	-.041	.038	.123	.118	-.018	-.027	.071
----------	----------	----------	----------	-.045	.004	.052	.102	-.037	.085	.124	-.014	.084	.132
----------	----------	----------	----------	----------	.838	.333	.285	.990	-.400	.465	-.036	-.069	.082
----------	----------	----------	----------	----------	----------	.383	.297	.838	-.285	.483	-.037	.114	.060
----------	----------	----------	----------	----------	----------	----------	.175	.340	-.158	.132	.045	.070	.130
----------	----------	----------	----------	----------	----------	----------	----------	.369	-.200	.164	.048	-.151	.116
----------	----------	----------	----------	----------	----------	----------	----------	----------	-.403	.469	-.028	-.083	.081
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	.332	.030	.055	.101
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	-.089	-.052	.236
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TABLE 28.—*Sorghum group for central area* ($n=431$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.282	0.457	−0.229	−0.415	0.044	0.600	0.157	0.210	−0.051	0.141	−0.158	−0.012	−0.129	−0.115
La		.246	−.306	−.011	.101	.329	.003	.039	−.029	.127	−.286	−.139	−.034	−.194
Al			−.270	−.711	.082	.079	−.008	.109	−.006	−.095	−.167	.000	−.121	−.185
T				.152	−.062	−.144	.048	.002	.560	−.025	.311	.222	.192	.370
TC					−.087	−.062	−.019	−.111	−.025	.017	.013	−.037	.064	.029
ST						.084	.188	.229	−.005	−.016	.003	.116	−.053	.015
S							.030	.046	−.038	.175	−.184	−.036	−.122	−.128
ER								.855	.145	−.077	.272	.312	.045	.298
EA									.120	−.127	.182	.241	.036	.199
L										−.049	.202	.164	.339	.349
DM											−.233	−.084	−.002	.165
DD												.143	.036	.537
DCh													.120	.609
DCu														.631
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.098 are significant at $P=0.05$.

TABLE 29.—*Wheat group for southern area* ($n=3,567$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.302	0.495	−0.303	−0.551	0.074	0.315	−0.182	0.173	0.045	0.111	0.018	0.017	0.045	0.092
La		−.158	−.162	−.393	−.000	.484	.063	.116	−.016	.135	.218	.008	−.187	.081
Al			−.299	−.546	−.155	−.322	.041	.057	.093	−.080	−.093	.083	.174	.076
T				.202	.073	−.013	−.017	−.081	−.459	−.118	−.127	−.094	−.003	−.191
TC					.061	−.048	−.005	−.065	−.226	−.103	−.101	−.026	−.071	−.174
ST						.298	.150	.111	−.064	.127	−.084	−.107	.109	−.011
S							.230	.134	−.069	.175	.026	−.024	−.075	.010
ER								.521	−.060	.060	−.047	.011	.044	.021
EA									.012	.053	.001	.033	.015	.049
L										.206	.245	.162	.170	.463
DM											−.064	−.048	.054	.298
DD												−.168	−.320	.384
DCh													.002	.477
DCu														.471
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.062 are significant at $P=0.05$.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.086	0.143	−0.165	−0.097	−0.157	−0.170	−0.034	−0.121	−0.161	−0.115	−0.246	−0.035	0.015	−0.192
.142	.099	.037	.092	−.163	−.175	−.085	−.063	−.165	−.004	−.126	−.004	−.058	−.202
.207	.152	−.134	.196	−.231	−.334	−.202	−.502	−.271	.020	−.236	−.026	−.054	−.146
−.046	−.214	−.011	.020	.495	.128	.044	.130	.489	−.227	.136	−.005	.034	.243
−.038	−.124	.096	−.119	.128	.214	.093	.470	.169	−.047	.102	−.012	−.001	.076
−.071	−.006	−.106	.021	.038	.063	−.074	.007	.038	.113	.169	−.102	−.032	.088
.108	.048	.011	−.058	−.089	−.063	.018	.063	−.079	−.025	−.060	−.097	−.023	−.159
−.156	.160	−.156	−.240	.382	.353	.289	.240	.400	−.332	−.155	.054	.125	.059
−.135	.173	−.141	−.192	.294	.253	.244	.209	.312	−.327	−.183	.028	.109	.040
.037	−.088	.036	−.096	.685	.084	.060	.091	.670	−.438	.222	.067	.059	.223
−.099	.009	−.038	−.246	−.052	−.015	−.021	.087	−.045	.034	.050	−.039	−.091	−.000
−.460	−.092	−.123	−.101	.329	.205	.146	.015	.322	−.097	.069	.058	.128	.282
−.342	−.108	−.088	−.095	.258	.175	.130	−.105	.239	−.049	.043	−.035	.053	.271
−.424	−.144	.111	−.222	.214	−.031	−.039	.047	.211	.021	.100	.171	.068	.133
−.685	−.179	−.057	−.296	.399	.174	.115	.010	.387	−.049	.125	.087	.097	.357
	.159	.077	.219	−.049	−.078	−.025	−.011	−.047	−.090	−.003	−.071	−.094	−.266
		−.093	.059	−.065	−.019	.051	.038	−.056	−.153	−.206	−.082	−.009	−.039
			.181	.009	.009	.057	.072	.009	.039	.102	−.017	−.034	.102
				−.159	−.091	−.102	−.137	−.168	.134	.025	−.118	−.119	.043
					.693	.407	.280	.994	−.468	.454	−.047	.117	.349
						.504	.288	.697	−.308	.458	−.138	.240	.250
							.156	.407	−.270	.171	−.041	.190	.198
								.369	−.302	.061	−.021	−.033	.029
									−.486	.442	−.043	.169	.334
										.344	.006	−.176	.003
											−.074	.099	.329
												.027	−.246
													.064

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	I	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
−0.047	0.083	−0.087	−0.064	0.013	−0.007	−0.241	0.160	0.011	0.056	0.048	0.343	−0.233	−0.218
−.105	−.175	−.089	.044	−.025	.064	−.136	.230	−.019	.046	.025	−.244	−.181	.100
.026	.176	−.265	−.070	−.031	−.156	−.312	.040	−.033	.042	.010	.520	−.292	−.229
−.120	.020	.063	.176	−.266	.033	.108	−.384	−.269	.039	−.140	−.126	.174	.205
.026	−.017	.186	−.032	−.041	.132	.246	−.279	−.043	−.030	−.057	−.267	.255	.047
−.067	−.037	.055	−.140	−.035	−.004	−.023	−.068	−.037	.152	.117	.118	.110	−.080
−.078	−.101	.218	−.046	−.044	.040	−.046	.061	−.042	.026	−.023	−.099	.067	−.004
−.062	.068	−.071	−.138	.014	.066	.002	−.009	.012	.011	−.014	.095	−.049	−.048
−.036	.035	−.057	−.168	.149	.164	−.022	.008	.145	−.035	.063	.078	−.094	−.128
.220	−.043	.008	−.245	.562	−.146	−.024	.631	.569	−.108	.299	.085	−.036	−.066
−.022	−.064	.057	−.181	.094	−.038	−.024	.175	.097	.041	.108	.019	−.010	.000
−.336	−.183	−.086	−.088	.300	.175	.084	.211	.299	−.045	.208	−.115	−.060	−.054
−.230	−.054	.006	−.059	.154	.048	.010	.105	.154	.003	.119	−.027	−.049	−.047
−.249	−.049	.012	−.195	.094	−.060	−.036	−.027	.096	.048	.130	.252	−.038	.038
−.565	−.222	−.031	−.295	.408	.101	.034	.256	.410	.013	.346	.078	−.104	−.042
	.232	.078	.093	−.019	−.211	−.068	.098	−.014	−.058	−.090	−.023	.045	.032
		.030	.090	−.057	−.052	−.015	−.038	−.056	−.130	−.205	.143	.064	−.018
			.005	−.055	−.078	.143	−.046	−.054	.036	−.052	−.100	.232	.125
				−.332	−.136	−.007	.026	−.328	.065	−.211	−.128	.085	.003
					.690	.353	.312	.997	−.244	.539	.020	−.134	−.203
						.441	−.069	.684	−.197	.379	−.086	−.156	−.191
							−.076	.347	−.122	.186	−.203	.058	.076
								.328	−.067	.117	.009	−.111	−.111
									−.242	.538	.016	−.133	−.201
										.495	.003	.003	.016
											.051	−.102	−.133
												−.101	−.338
													.057

TABLE 30.—*Oat group for southern area* ($n=295$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.164	−0.131	−0.094	−0.075	0.070	0.723	0.390	0.030	−0.098	0.059	−0.092	−0.134	0.090	−0.078
La		−.400	.046	−.101	.282	.419	.245	−.283	.183	.095	.181	−.321	.051	.058
Al			−.123	−.268	−.651	−.472	−.145	−.014	−.200	−.329	−.002	.265	−.020	−.080
T				.043	.054	.005	−.168	−.021	.402	.101	.349	.109	.006	.387
TC					.032	.020	−.108	.013	−.010	−.008	.001	−.025	.034	−.007
ST						.313	.168	−.055	.211	.346	−.110	−.168	.081	.177
S							.388	−.067	.053	.105	−.008	−.211	.136	−.008
ER								−.079	.012	.134	.071	−.142	.114	.101
EA									−.051	−.062	−.021	−.053	−.045	−.115
L										.062	.329	.077	−.026	.330
DM											−.454	−.124	.238	.368
DD												−.125	−.254	.297
DCh													.008	.437
DCu														.340
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.114 are significant at $P=0.05$.

TABLE 31.—*Barley group for southern area* ($n=498$),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.468	0.012	0.135	−0.462	0.217	0.667	0.365	0.032	0.050	0.056	0.122	−0.019	0.044	0.118
La		−.252	.241	−.504	.357	.556	.347	.161	.022	.073	.204	−.181	.072	.075
Al			−.102	−.318	−.392	−.376	−.234	.026	.038	.065	−.169	.262	.060	.101
T				−.169	.152	.078	.093	.110	.337	.114	.522	.113	.121	.539
TC					−.063	−.190	−.070	−.203	.003	−.199	−.130	−.023	−.156	−.221
ST						.403	.323	.041	−.016	.017	.047	−.073	.037	.012
S							.498	−.004	−.015	−.014	.071	−.168	.053	−.037
ER								.176	.055	−.016	.102	−.094	.005	−.005
EA									−.004	−.014	.075	.031	−.019	.067
L										.026	.331	.127	−.001	.347
DM											.020	.073	.012	.352
DD												−.342	−.100	.417
DCh													−.004	.543
DCu														.310
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.089 are significant at $P=0.05$.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.047	−0.035	0.021	−0.062	−0.132	−0.132	−0.097	0.104	−0.143	0.093	0.005	−0.006	0.027	−0.223
.057	.142	−.240	−.196	.243	.229	.218	−.126	.228	−.162	.253	−.018	.196	−.034
−.102	−.049	−.075	.311	−.320	−.269	−.393	−.014	−.326	.251	−.111	−.026	.099	.067
−.151	.071	−.074	−.194	.404	.389	.206	.102	.399	−.346	−.022	−.037	.286	.127
−.043	−.001	.019	.052	.065	.078	.067	.006	.587	−.060	−.076	.000	−.055	.003
.139	.141	.088	−.219	.287	.210	.300	−.076	.284	−.112	.245	.146	−.118	−.050
.040	.100	.055	−.138	.071	.013	.111	−.026	.055	−.108	.045	.014	.038	−.212
−.082	.017	−.292	−.154	.227	.255	.137	−.035	.220	.032	.341	−.050	−.004	.138
.088	−.098	.176	.030	−.051	−.039	−.011	.444	−.052	−.053	−.134	−.096	−.062	.050
.168	.047	−.126	−.290	.727	.236	.180	.033	.723	−.394	.203	.093	−.087	.026
.036	−.054	.016	−.525	.110	.124	.105	−.028	.114	−.061	.149	−.088	−.042	.074
−.419	−.072	−.197	−.002	.333	.219	.099	.044	.326	−.192	.012	−.034	.146	.094
−.307	−.060	.109	.136	.048	−.004	−.052	−.023	.045	.038	.030	.043	−.012	.108
−.259	−.065	−.009	−.085	.093	.173	.065	−.020	.089	.033	.197	.013	.063	.128
−.641	−.151	−.090	−.306	.406	.340	.144	−.008	.400	−.146	.238	−.055	.097	.230
-----	.152	.038	−.013	−.012	−.144	−.005	−.011	−.004	−.056	−.047	.048	−.143	−.158
-----	-----	.092	.164	.112	.151	.148	−.044	.104	−.047	.095	.244	−.035	−.038
-----	-----	-----	.168	−.177	−.167	.047	.078	−.167	.193	−.042	.113	−.083	−.012
-----	-----	-----	-----	−.294	−.170	−.122	−.003	−.303	.162	−.107	.196	.006	.079
-----	-----	-----	-----	-----	.782	.464	.016	.993	−.472	.358	.015	.013	.284
-----	-----	-----	-----	-----	-----	.527	−.017	.776	−.369	.343	−.002	.160	.359
-----	-----	-----	-----	-----	-----	-----	.016	.471	−.278	.223	.018	.073	.178
-----	-----	-----	-----	-----	-----	-----	-----	.013	−.059	−.111	−.043	−.084	.013
-----	-----	-----	-----	-----	-----	-----	-----	-----	−.474	.359	.013	.014	.279
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.306	.019	−.093	−.056
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	−.010	.002	.265
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	−.031	−.325
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.128

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
−0.028	−0.115	−0.062	−0.126	0.070	0.079	−0.034	0.200	0.068	0.014	0.039	−0.017	0.205	−0.168
.001	.035	−.302	−.105	.175	.277	.015	.204	.173	−.044	.232	.013	.424	−.271
.012	.066	.133	.173	−.067	−.108	−.125	.145	−.061	018	−.253	−.098	−.093	.136
−.355	−.009	−.171	−.332	.515	.595	.201	−.027	.499	−.313	.093	−.015	.458	−.061
.072	.029	.090	.009	−.080	−.153	.007	−.421	−.086	.035	−.013	.048	−.235	.077
.017	.072	−.084	−.246	.072	.137	.028	−.017	.067	.004	.167	.101	.050	−.111
.054	.056	−.094	−.177	.023	.035	.009	.091	.018	−.020	.064	.031	.209	−.207
−.012	.104	−.061	−.138	.139	.127	.102	.175	.135	−.006	.223	.088	.197	−.085
−.071	−.015	−.055	−.071	.033	.083	.017	.517	.036	−.023	.023	−.027	.096	−.062
.112	−.004	−.111	−.411	.701	.090	.049	.023	.690	−.370	.138	.079	−.148	−.014
−.147	.032	.033	−.155	.120	.160	.074	−.014	.122	.004	.100	−.039	.122	.012
−.417	−.163	−.180	−.256	.380	.309	.068	.016	.368	−.204	.065	−.083	.237	.089
−.355	−.018	.103	−.095	.085	.029	−.027	−.038	.099	.034	.147	−.051	−.069	.040
−.216	.041	.030	.034	.070	.144	.068	.006	.068	−.057	.000	−.001	.035	.135
−.723	−.085	−.022	−.283	.407	.343	.084	−.020	.408	−.140	.213	−.082	.170	.009
-----	.150	−.072	−.080	−.028	−.220	−.030	.003	−.036	−.068	−.118	.154	−.213	−.020
-----	-----	−.089	.019	.182	.210	.229	−.034	.176	−.083	.163	.391	.004	−.084
-----	-----	-----	.036	−.253	−.243	−.023	−.015	−.229	.273	.052	−.009	−.148	.228
-----	-----	-----	-----	−.420	−.219	−.172	−.014	−.407	.195	−.120	−.033	.033	.018
-----	-----	-----	-----	-----	.711	.450	−.004	.981	−.502	.438	.120	.161	.050
-----	-----	-----	-----	-----	-----	.551	−.030	.694	−.398	.336	.092	.433	.063
-----	-----	-----	-----	-----	-----	-----	−.033	.440	−.287	.207	.096	.128	.125
-----	-----	-----	-----	-----	-----	-----	-----	.007	.009	.016	−.011	.049	−.010
-----	-----	-----	-----	-----	-----	-----	-----	-----	−.500	.357	.112	.161	.045
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.243	−.051	−.099	−.129
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.197	.123	−.008
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	−.015	−.199
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	−.025

TABLE 32.—*Sorghum group for southern area* (n=*1,578*),

Factor symbol	*La*	*Al*	*T*	*TC*	*ST*	*S*	*ER*	*EA*	*L*	*DM*	*DD*	*DCh*	*DCu*	*D*
LC	0.459	0.505	−0.372	−0.498	0.279	0.201	0.307	0.216	−0.155	0.025	−0.256	−0.132	−0.023	−0.273
La		−.115	−.054	−.177	−.014	.621	.247	.152	−.100	−.048	.208	.017	−.037	.084
Al			−.398	−.531	.199	−.450	.147	.217	−.059	−.148	−.330	−.065	.112	−.342
T				.264	−.249	.097	−.134	−.064	.243	−.123	.277	.140	−.017	.199
TC					−.253	.037	−.237	−.290	.217	−.007	.257	.127	−.014	.276
ST						.119	.295	.202	−.230	.199	−.393	−.276	−.049	−.331
S							.230	.065	−.133	.086	.161	−.109	−.092	.055
ER								.733	−.163	.011	−.110	−.091	−.079	−.165
EA									−.125	−.081	−.087	−.025	−.031	−.153
L										−.068	.270	.118	.057	.253
DM											−.322	−.132	−.161	.281
DD												−.026	−.129	.371
DCh													.066	.532
DCu														.355
D														
TI														
W														
C														
M														
TR														
WR														
I														
WP														
P														
ME														
IM														
WH														
SD														

[1] With 1,000 degrees of freedom, values exceeding 0.062 are significant at P=0.05.

1947–51: Simple correlation coefficients [1]

TI	*W*	*C*	*M*	*TR*	*WR*	*I*	*WP*	*P*	*ME*	*IM*	*WH*	*SD*	*Y*
0.232	−0.079	−0.062	0.161	−0.171	−0.083	−0.157	0.243	−0.163	0.273	0.296	−0.075	0.006	−0.129
−.148	−.144	−.033	−.033	.202	.316	.067	.463	.206	−.052	.235	−.213	−.006	−.009
.356	−.007	−.193	.242	−.369	−.390	−.299	.124	−.362	.279	.080	.131	.106	−.092
−.146	.039	.071	−.268	.157	.169	.129	−.069	.159	−.345	−.405	−.079	.155	−.001
−.231	.034	.162	−.138	.291	.197	.091	−.306	.287	−.283	−.080	−.022	−.052	.078
.309	−.004	−.183	.148	−.324	−.252	−.254	−.105	−.316	.502	.319	−.033	.096	−.104
−.167	−.094	−.007	−.126	.158	.284	.117	.198	.163	−.085	.132	−.202	−.012	−.066
.087	.086	−.151	−.036	−.114	−.024	−.002	.308	−.099	.170	.083	−.003	.060	−.091
.086	.067	−.141	−.030	−.139	−.078	−.034	.323	−.126	.146	−.050	−.031	.119	−.067
.140	−.121	.037	−.190	.511	−.053	.053	−.051	.510	−.379	−.104	.045	.024	−.011
−.067	.010	.095	−.090	.062	.119	.072	.019	.007	.144	.241	.116	−.121	.090
−.417	−.132	.006	−.216	.371	.278	.156	.114	.378	−.399	−.165	−.050	−.030	.068
−.275	−.040	.154	−.074	.171	.185	.049	.157	.125	−.142	−.076	.026	.068	.249
−.308	−.003	.038	−.033	.002	−.051	−.030	−.016	.007	.012	.015	−.003	−.046	.124
−.732	−.117	.203	−.293	.404	.316	.194	.095	.376	−.300	.016	.033	−.129	.219
	.059	−.141	.195	−.208	−.324	−.222	−.050	−.233	.260	.020	.038	.180	−.204
		.006	.073	−.051	.018	.035	−.071	−.055	.032	−.029	−.210	−.034	−.008
			.019	.114	.092	.141	−.062	.110	−.118	.022	−.024	−.118	.266
				−.221	−.172	−.141	−.024	−.222	.254	.157	−.029	−.065	−.090
					.759	.511	.065	.985	−.569	.228	−.076	−.198	.177
						.514	.149	.720	−.425	.242	−.111	−.171	.210
							.023	.512	−.402	.076	−.050	−.203	.047
								.039	−.025	−.029	.034	−.012	.068
									−.590	.220	−.094	−.215	.154
										.485	.054	.107	−.067
											−.031	−.231	.083
												−.084	−.156
													−.077

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